

STANDARD PLANS LIST

The standard plan sheets applicable to this Contract include those listed below. When applicable, revised standard plans (RSPs) listed below are included in the project plans.

ABBREVIATIONS, LINES, SYMBOLS, AND LEGEND

RSP A3A	Abbreviations (Sheet 1 of 3)
A3B	Abbreviations (Sheet 2 of 3)
A3C	Abbreviations (Sheet 3 of 3)
A10A	Legend - Lines and Symbols (Sheet 1 of 5)
A10B	Legend - Lines and Symbols (Sheet 2 of 5)
A10C	Legend - Lines and Symbols (Sheet 3 of 5)
A10D	Legend - Lines and Symbols (Sheet 4 of 5)
A10E	Legend - Lines and Symbols (Sheet 5 of 5)

EXCAVATION AND BACKFILL

A62B	Limits of Payment for Excavation and Backfill - Bridge Surcharge and Wall
A62C	Limits of Payment for Excavation and Backfill - Bridge

CURBS, DRIVEWAYS, DIKES, CURB RAMPS AND ACCESSIBLE PARKING

A87B	Hot Mix Asphalt Dikes

TEMPORARY CRASH CUSHIONS, RAILING AND TRAFFIC SCREEN

T1A	Temporary Crash Cushion, Sand Filled (Unidirectional)
T1A1	Temporary Crash Cushion, Sand Filled (Unidirectional)
T1B	Temporary Crash Cushion, Sand Filled (Bidirectional)
T2	Temporary Crash Cushion, Sand Filled (Shoulder Installations)
T3A	Temporary Railing (Type K)
T3B	Temporary Railing (Type K)
T3C	Temporary Barrier System (Cross Bolt)
T3D	Temporary Barrier System (Cross Bolt)
T3E	Temporary Barrier System (Cross Bolt)
RSP T3F	Temporary Barrier System (Cal F-23)
RSP T3F2	Temporary Barrier System (Cal F-23)
RSP T3G	Temporary Barrier System (Staking or Anchoring)
RSP T3G2	Temporary Barrier System (Staking or Anchoring)

BRIDGE DETAILS

B0-3	Bridge Details
B0-5	Bridge Details
B0-13	Bridge Details

RETAINING WALLS

B3-5	Retaining Wall Details No. 1

JOINT SEALS

B6-21	Joint Seals (Maximum Movement Range = 2")

BOX GIRDER DETAILS

B7-1	Box Girder Details

DECK DRAINS

B7-5	Deck Drains
B7-6	Deck Drains - Types D-1 and D-2
B7-7	Deck Drain - Type D-3
B7-8	Deck Drainage Details

UTILITY OPENING**B7-10 Utility Opening - Box Girder****B7-11 Utility Details****CAST-IN-PLACE POST-TENSIONED GIRDER****B8-5 Cast-In-Place Post-Tensioned Girder Details****CONCRETE BARRIERS****B11-83 Concrete Barrier Type 85 Details No. 1****B11-83A Concrete Barrier Type 85 Details No. 2****B11-84 Concrete Barrier Type 85 Details No. 3****B11-85 Concrete Barrier Type 85 Details No. 4****B11-86 Concrete Barrier Type 85 Details No. 5****B11-87 Concrete Barrier Type 85 Details No. 6****WATER SUPPLY LINE (BRIDGE)****RSP B14-5 Water Supply Line (Details) (Pipe Sizes Less Than 4")****ROADSIDE SIGNS****RS1 Roadside Signs - Typical Installation Details No. 1****RS2 Roadside Signs - Wood Post - Typical Installation Details No. 2****RS4 Roadside Signs - Typical Installation Details No. 4****ELECTRICAL SYSTEMS - LIGHTING STANDARDS****RSP ES-6A Electrical Systems (Lighting Standard, Types 15 and 21)****RSP ES-6B Electrical Systems (Electrolier Anchorage and Grouting for Type 15 and Type 21, Barrier Rail Mounted)****ELECTRICAL SYSTEMS - STRUCTURE INSTALLATIONS****ES-9A Electrical Systems (Structure Pull Box Installations)****ES-9B Electrical Systems (Conduit Riser Expansion and Deflection Fittings, Structure Installations)****ES-9C Electrical Systems (Structure Pull Box)****ES-9D Electrical Systems (Structure Pull Box Installations)****ES-9E Electrical Systems (Flush-Mounted Soffit, Pendant soffit and Wall-Mounted Luminaire Structure Installations)****ES-9F Electrical Systems (Flush-Mounted Soffit Luminaire Details)****ORGANIZATION**

Special provisions are under headings that correspond with the main-section headings of the *Standard Specifications*. A main-section heading is a heading shown in the table of contents of the *Standard Specifications*.

Each special provision begins with a revision clause that describes or introduces a revision to the *Standard Specifications*.

Any paragraph added or deleted by a revision clause does not change the paragraph numbering of the *Standard Specifications* for any other reference to a paragraph of the *Standard Specifications*.

DIVISION I GENERAL PROVISIONS

1 GENERAL

Add to section 1-1.01:

Bid Items and Applicable Sections		
Item code	Item description	Applicable section

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2 BIDDING

Add between the 1st and 2nd paragraphs of section 2-1.06B:

The Department makes the following supplemental project information available:

Draft
(Not for Bidding)

Supplemental Project Information

Means	Description
Included in the <i>Information Handout</i>	Final Foundation Report for I Street Bridge (Replace) Dated XXXXXX
Available as specified in the <i>Standard Specifications</i>	Roadway Design Alignments Bridge As-Built Drawings I Street Bridge (Br. No. 22C-0153 and 22-0033) As-Built Drawings Sacramento River Approach (Br. No. 22C-1054) As-Built Drawings J Street Viaduct (Br. No. 24C-0364R) As-Built Drawings I Street Viaduct (Br. No. 24C-0364L) As-Built Drawings Jibboom Street Viaduct (Br. No. 24C-0006) As-Built Drawings 3-D Model digital files for the traffic warning gate monument 3-D Model digital files for the Approach Spans exterior girder architectural flare layout. Digital files for the monument emblem detail for the railing monument. Digital files for the custom manhole cover for the approach spans. Digital files for the bridge number plaque detail. Digital files for the bridge designer's plaque detail. Permanent Steel Casing purchase order
Included with the project plans	Log of Test Borings

5 CONTROL OF WORK

Replace section 5-1.13E with:

5-1.13E Prompt Payment

Section 5-1.13E applies to all contracts.

Pay your subcontractors within 7 days of receipt of each progress payment under Pub Cont Code §§ 10262 and 10262.5. Pay duly authorized motor carriers of property in dump trucks for transportation charges under Bus & Prof Code § 7108.6. Pay other entities, such as material suppliers, within 30 days of receipt of each progress payment.

Each month, after the 15th and prior to 20th, submit the following payment information through the Department's prompt payment monitoring system at <https://caltrans.dbesystem.com>:

1. Subcontractor's or entity's business name
2. Description of work performed
 - 2.1. Bid item numbers or change order numbers
 - 2.2. Written narrative of work performed
3. Value of work performed
4. Amount paid to subcontractor or entity
5. Withhold amount, if applicable
6. Explanation of withhold reasoning, if applicable

Your subcontractors and other entities may validate payments received using the prompt payment monitoring system.

If a subcontractor's or other entity's work is in dispute, provide a written withhold notification to the subcontractor or entity and the Engineer no later than 7 days after receipt of the corresponding progress payment that includes the following:

1. Value of the disputed work
2. Amount of the withhold being taken
3. Bid item numbers or change order numbers associated with the disputed work
4. Explanation of the deficiencies of the disputed work and how the corresponding value was calculated
5. Corrective actions to be taken for release of withheld amount

The Department may request additional documentation from you to evaluate whether you applied the withhold in good faith. Submit requested documents within 10 days of receipt of request.

The Department may withhold the same amount of your withhold from a future progress pay estimate if the Department determines any of the following has occurred:

1. Withhold was not applied in good faith
2. Requested additional withhold documentation records were not provided
3. Payment information was not submitted through the prompt payment monitoring system
4. Required withhold notification was not provided

The Department may also apply a 2 percent penalty on the withhold amount for every month payment is not made.

Add to section 5-1.23A:

Submittals must be complete and organized to allow the review and evaluation of logical groups of items. Consideration must be given to the quantity of shop drawings submitted at one time. Submit packages for review as soon as they are complete rather than submitting packages in bulk.

Submittals that are incomplete, disorganized, or submitted in bulk may be returned without review or may be subject to extended review periods at the discretion of the Engineer.

If a large volume of submittals is submitted simultaneously or in rapid succession, the Engineer will not be responsible for adhering to the review turnaround times specified herein. The review period for such submittals will be determined by the Engineer.

6 CONTROL OF MATERIALS

Replace section 6-1.03B with:**6-1.03B Submittals****6-1.03B(1) General**

Not Used

6-1.03B(2) Work Plan

For local material, such as rock, gravel, earth, structure backfill, pervious backfill, imported borrow, and culvert bedding, obtained from a (1) noncommercial source, or (2) source not regulated under California jurisdiction, submit a local material plan for each material at least 60 days before placing the material. The local material plan must include:

1. Certification signed by you and an engineer who is registered as a civil engineer in the State or a professional geologist licensed as a professional geologist by the State stating:

I am aware local material from a noncommercial source or a source not regulated under CA jurisdiction must be sampled and analyzed for pH and lead and may require sampling and analysis under section 6-1.03B(3) for other constituents of concern based on the land use history. I am aware that local material sources must not contain ADL at concentrations greater than 80 mg/kg total lead or equal to or greater than 5 mg/L soluble lead as determined by the Waste Extraction Test (WET) Procedures, 22 CA Code of Regs § 66261.24(a)(2) App II. I am aware that a maximum quantity of material may be excavated at the site based on the minimum number of samples taken before excavating at the site under section 6-1.03B(3).

2. Land use history of the local material location and surrounding property
3. Sampling protocol
4. Number of samples per volume of local material
5. QA and QC requirements and procedures
6. Qualifications of sampling personnel
7. Stockpile history
8. Name and address of the analytical laboratory that will perform the chemical analyses
9. Analyses that will be performed for lead and pH
10. Other analyses that will be performed for possible hazardous constituents based on:
 - 10.1. Source property history
 - 10.2. Land use adjacent to source property
 - 10.3. Constituents of concern in the ground water basin where the job site is located

The plan must be sealed and signed by an engineer who is registered as a civil engineer in the State or a professional geologist licensed as a professional geologist by the State.

If the plan requires revisions, the Engineer provides comments. Submit a revised plan within 7 days of receiving comments. Allow 7 days for the review.

6-1.03B(3) Analytical Test Results

At least 15 days before placing local material, submit analytical test results for each local material obtained from a noncommercial source or a source not regulated under CA jurisdiction. The analytical test results must include:

1. Certification signed by an engineer who is registered as a civil engineer in the State or a professional geologist licensed as a professional geologist by the State stating:

The analytical testing described in the local material plan has been performed. I performed a statistical analysis of the test results using the US EPA's ProUCL software with the applicable 95 percent upper confidence limit. I certify that the material from the local material source is suitable for unrestricted use at the job site, it has a pH above 5.0, does not contain soluble lead in concentrations equal to or greater than 5mg/l as determined by the Waste Extraction Test (WET) Procedures, 22 CA Code of Regs § 66261.24(a)(2) App II, does not contain lead in concentrations above 80 mg/kg total lead, is free from all other contaminants identified in the local material plan, and will comply with the job site's basin plan and water quality objectives of the RWQCB.

2. Chain of custody of samples
3. Analytical results no older than 1 year
4. Statistical analysis of the data using US EPA's ProUCL software with a 95 percent upper confidence limit
5. Comparison of sample results to hazardous waste concentration thresholds and the RWQCB's basin plan requirements and water quality objectives for the job site location

6-1.03B(4) Sample and Analysis

Sample and analyze local material from a (1) noncommercial source or (2) a source not regulated under CA jurisdiction:

1. Before bringing the local material to the job site
2. As described in the local material plan
3. Under US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)

The sample collection must be designed to generate a data set representative of the entire volume of proposed local material.

Before excavating at the (1) noncommercial material source or (2) a source not regulated under CA jurisdiction, collect the minimum number of samples and perform the minimum number of analytical tests for the corresponding maximum volume of local material as shown in the following table:

Minimum Number of Samples and Analytical Tests for Local Material

Maximum volume of imported borrow (cu yd)	Minimum number of samples and analytical tests
< 5,000	8
5,000–10,000	12 for the first 5,000 cu yd plus 1 for each additional 1,000 cu yd or portion thereof
10,000–20,000	17 for the first 10,000 cu yd plus 1 for each additional 2,500 cu yd or portion thereof
20,000–40,000	21 for the first 20,000 cu yd plus 1 for each additional 5,000 cu yd or portion thereof
40,000–80,000	25 for the first 40,000 cu yd plus 1 for each additional 10,000 cu yd or portion thereof
> 80,000	29 for the first 80,000 cu yd plus 1 for each additional 20,000 cu yd or portion thereof

Do not collect composite samples or mix individual samples to form a composite sample.

Analyze the samples using the US EPA's ProUCL software with a 95 percent upper confidence limit. All chemical analysis must be performed by a laboratory certified by the SWRCB's Environmental Laboratory Accreditation Program (ELAP).

The analytical test results must demonstrate that the local material:

1. Is not a hazardous waste
2. Has a pH above 5.0
3. Has an average total lead concentration, based upon the 95 percent upper confidence limit, at or below 80 mg/kg
4. Is free of possible contaminants identified in the local material plan
5. Complies with the RWQCB's basin plan for the job site location
6. Complies with the RWQCB's water quality objectives for the job site location

6-1.03B(3) Analytical Test Results

At least 15 days before placing local material, submit analytical test results for each local material obtained from a noncommercial source or a source not regulated under CA jurisdiction. The analytical test results must include:

1. Certification signed by an engineer who is registered as a civil engineer in the State or a professional geologist licensed as a professional geologist by the State stating:

The analytical testing described in the local material plan has been performed. I performed a statistical analysis of the test results of the analytical testing described in the local material plan using the US EPA's ProUCL software with the applicable 95 percent upper confidence limit. I certify that the material from the local material source is suitable for unrestricted use at the job site and the material has met the following criteria:

1. Has a pH above 5.0.
 2. Does not contain soluble lead in concentrations equal to or greater than 5 mg/L as determined by the Waste Extraction Test (WET) Procedures, 22 CA Code of Regs § 66261.24(a)(2) App II.
 3. Does not contain lead in concentrations above 80 mg/kg total lead.
 4. Is not contaminated with the other constituents of concern identified in the local material plan in average concentration (95 percent upper confidence limit) in excess of these constituents' respective San Francisco Bay RWQCB commercial/industrial environmental screening levels (ESLs), except for arsenic.
 5. Does not exceed the maximum allowed concentration limit table listed in Section 6-1.03B(4).
2. Chain of custody of samples.
 3. Analytical results no older than 1 year.
 4. Statistical analysis of the data using US EPA's ProUCL software with a 95 percent upper confidence limit.
 5. Comparison of sample results and 95 percent upper confidence limits to hazardous waste concentration thresholds and the applicable San Francisco Bay RWQCB environmental screening levels (ESLs) given in direct exposure human health risk levels (Table S-1), commercial/industrial: Shallow soil exposure, under Summary of Soil ESLs tables (2019 Rev 2). The Summary of Soil ESLs tables (2019 Rev 2) can be obtained by sending an email to ESLs.ESLs@waterboards.ca.gov with "Request for ESL Documents" in the subject line.

6-1.03B(4) Sample and Analysis

Sample and analyze local material from a (1) noncommercial source or (2) a source not regulated under CA jurisdiction:

1. Before bringing the local material to the job site
2. As described in the local material plan
3. Under US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)

The sample collection must be designed to generate a data set representative of the entire volume of proposed local material.

Before excavating at (1) a noncommercial material source or (2) a source not regulated under CA jurisdiction, collect the minimum number of samples, and perform the minimum number of analytical tests for the corresponding maximum volume of local material as shown in the following table:

Minimum Number of Samples and Analytical Tests for Local Material

Maximum volume of imported borrow (cu yd)	Minimum number of samples and analytical tests
< 5,000	8
5,000–10,000	12 for the first 5,000 cu yd plus 1 for each additional 1,000 cu yd or portion thereof
10,000–20,000	17 for the first 10,000 cu yd plus 1 for each additional 2,500 cu yd or portion thereof
20,000–40,000	21 for the first 20,000 cu yd plus 1 for each additional 5,000 cu yd or portion thereof
40,000–80,000	25 for the first 40,000 cu yd plus 1 for each additional 10,000 cu yd or portion thereof
> 80,000	29 for the first 80,000 cu yd plus 1 for each additional 20,000 cu yd or portion thereof

Do not collect composite samples or mix individual samples to form a composite sample.

Statistically analyze the samples' laboratory results using the US EPA's ProUCL software to define 95 percent upper confidence limit for the various contaminants of concern. All chemical analysis must be performed by a laboratory certified by the SWRCB's Environmental Laboratory Accreditation Program (ELAP).

The analytical test results must demonstrate that the local material:

1. Is not a hazardous waste
2. Has a pH above 5.0
3. Has an average total lead concentration, based upon the 95 percent upper confidence limit, at or below 80 mg/kg
4. Is not contaminated with local material plan-identified constituents of concern at average concentrations (95 percent upper confidence limits) in excess of their respective commercial/industrial San Francisco Bay RWQCB environmental screening levels ESLs, except for arsenic.
5. Does not contain any of the following compounds, chemicals, or elements at an estimated average concentration (95 percent upper confidence limit) above the maximum allowed concentration defined in the following table:

Compound/Chemical	Maximum allowed concentration (mg/kg)
Arsenic	11
Barium	1500
Benzene	1
Beryllium	10
Cadmium	10
Chromium (total)	1000
Cobalt	100
Diesel	150
Ethylbenzene	10
Gasoline	500
Mercury	10
Motor oil	500
Nickel	150
Selenium	10
Toluene	10
Trichloroethene	1
Vanadium	200
Xylenes	10
Zinc	600

6-1.03C Local Material Management

Do not place local material until authorized.

If the Engineer determines the appearance, odor, or texture of any delivered local material suggests possible contamination, sample and analyze the material. The sampling and analysis is change order work unless (1) hazardous waste is discovered or (2) the analytical test results indicate the material does not comply with section 6-1.03B(3).

Dispose of noncompliant local material at an appropriately permitted CA Class I, CA Class II or CA Class III facility. You are the generator of noncompliant local materials.

Replace section 6-1.04 with:

6-1.04 BUY AMERICA**6-1.04A General**

Buy America requirements do not apply to the following:

1. Tools and construction equipment used in performing the work
2. Temporary work that is not incorporated into the finished project

6-1.04B Crumb Rubber (Pub Res Code § 42703(d))

Furnish crumb rubber with a certificate of compliance. Crumb rubber must be:

1. Produced in the United States
2. Derived from waste tires taken from vehicles owned and operated in the United States

6-1.04C Steel and Iron Materials

Steel and iron materials must be melted and manufactured in the United States except:

1. Foreign pig iron and processed, pelletized, and reduced iron ore may be used in the domestic production of the steel and iron materials
2. If the total combined cost of the materials produced outside the United States does not exceed the greater of 0.1 percent of the total bid or \$2,500, the material may be used if authorized

Furnish steel and iron materials to be incorporated into the work with certificates of compliance and certified mill test reports. Mill test reports must indicate where the steel and iron were melted and manufactured.

All melting and manufacturing processes for these materials, including an application of a coating, must occur in the United States. Coating includes all processes that protect or enhance the value of the material to which the coating is applied.

6-1.04D Manufactured Products

Iron and steel used in precast concrete manufactured products must meet the requirements of section 6-1.04C regardless of the amount used.

Iron and steel used in other manufactured products must meet the requirements of section 6-1.04C if the weight of steel and iron components constitute 90 percent or more of the total weight of the manufactured product.

The following manufactured products have received an approved Buy America waiver for this Contract and are therefore not subject to Buy America requirements:

1. _____
2. _____

6-1.04E Construction Materials

The following construction materials must be produced in the United States under standards in 2 CFR 184.6:

1. Non-ferrous metals

2. Plastic and polymer-based products such as:
 - 2.1. Polyvinylchloride
 - 2.2. Composite building materials
3. Glass
4. Fiber optic cable including drop cable
5. Optical fiber
6. Lumber
7. Engineered wood
8. Drywall

All manufacturing processes for these materials as defined in 2 CFR 184.6 must occur in the United States.

Furnish construction materials to be incorporated into the work with certificates of compliance with each project delivery. Manufacturer's certificate of compliance must identify where the construction material was manufactured and attest specifically to compliance with its 2 CFR 184.6 standard.

Minor additions of articles, materials, supplies, or binding agents to these construction materials do not change the categorization of the construction material.

Add to section 6-1:

6-1.08 ENVIRONMENTAL PRODUCT DECLARATIONS FOR HOT MIX ASPHALT AND CONCRETE

Section 6-1.08 includes specifications for environmental product declarations for hot mix asphalt and concrete materials and products.

See section 6-1.06B for definitions.

For projects with bid opening dates after February 1, 2025, with a total bid over \$1 million and 175 or more original working days, materials or products specified in the following table require facility-specific, product stage, environmental product declarations as informational submittals:

Material or product	Material specifications
Hot mix asphalt ^a	Section 39-2, "Hot Mix Asphalt" Excludes RHMA, OGFC, and BWC materials.
Concrete ^b	Section 28-2, "Lean Concrete Bases," Section 28-3, "Rapid Strength Concrete Base," Section 28-4, "Lean Concrete Base Rapid Setting," Section 28-5, "Concrete Base," Section 40, "Concrete Pavement," Section 47-5, "Type 6 Retaining Walls," Section 49-3, "Cast-In-Place Concrete Piling," Section 49-4, "Steel Soldier Piling," Section 51, "Concrete Structures," Section 58-2, "Masonry Block," Section 73, "Concrete Curbs and Sidewalks," Section 83, "Railings and Barriers," and Section 99, "Building Construction." Excludes volumetric-proportioned rapid strength concrete and Section 90-4 PC concrete members.

^aFor each hot mix asphalt plant providing 2,250 tons or more on the project by job mix formula.

^bFor each concrete plant providing 250 cubic yards or more on the project by mix design.

The requirements in section 6-1.08 do not apply to seasonal plants operating fewer than 6 months per year.

The requirements in section 6-1.08 do not apply to informal-bid contracts.

For product category rules for hot mix asphalt or concrete, go to the METS website. Use the product category rule in effect on the date of bid opening unless otherwise authorized. An environmental product declaration for hot mix asphalt or concrete is not required for either of the following conditions:

1. Applicable product category rule has expired without replacement as of the bid opening date.
2. Applicable product category rule was issued less than 50 days before the bid opening date.

Immediately notify the Engineer if a program operator has determined their product category rule does not allow for development of a facility-specific environmental product declaration. Include written correspondence from the program operator with your notification to the Engineer. If the Engineer determines the development of

You must register on the Department's Data Interchange for Materials Engineering (DIME) at least 15 days before submitting environmental product declarations. Follow the registration process at:

Within 30 days of initial placement of each applicable material or product, submit a facility-specific, product stage, environmental product declaration informational submittal to DIME and provide proof of submission in PDF file format to the Engineer. The DIME entry information must include intended use of materials and estimated quantities of materials to be used as represented by the environmental product declaration.

7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Delete the 24th paragraph of section 7-1.04.

8 PROSECUTION AND PROGRESS

Submit to the engineer a practicable progress schedule and a schedule of values at the pre-construction meeting and within 5 days of the Engineer's written request at any other time. The progress schedule shall show the other in which the Contractor proposed to carry out the work, the dates on which the Contractor will start the features of the work and the contemplated dates for completion of the work. The schedule of values is submitted for use in determining progress payments. The progress schedules submitted shall be consistent in all respects with the time and order of work requirements of the contract.

1. A total of 25 percent of the item amount will be paid upon achieving all of the following:

- If you fail to complete any of the work or provide any of the schedules required by this section, the Engineer makes an adjustment in compensation as specified in Section 4-1.03C of the State Standard Specifications for the work not performed. Adjustments in compensation for schedules will not be made for any increased or decreased work ordered by the Engineer in submitting schedules.

8-1.04C Delayed Start

Start job site activities within 55 days after receiving notice that the Contract has been approved by the Attorney General or the attorney appointed and authorized to represent the Department.

1. Biological resource information program
2. CPM baseline schedule
3. WPCP or SWPPP, whichever applies
4. Notification of DRA or DRB nominee and disclosure statement
5. Natural resource protection plan
6. Contingency plan for opening closures to traffic

Do not start other job site activities until all the submittals from the above list are authorized or accepted and the following information is received by the Engineer:

- You may start job site activities before the 55th day after Contract approval if you:

- Submit a notice 72 hours before starting job site activities. If the project has more than 1 location of work, submit a separate notice for each location.

[illegible]

DIVISION II GENERAL CONSTRUCTION

10 GENERAL

Replace section 10-1.03 with:

10-1.03 TIME CONSTRAINTS

No work is allowed within 250 feet of the Sacramento River from December 1 to April 30.

In-water work must be conducted during daylight hours only.

Cofferdams will be installed and removed only during the proposed in-water work window (between May 1 and November 30).

Add to section 10-6:

Water used in construction must comply with section 15-1 of the City's Standard Specification.

Within the City of West Sacramento the Contractor is responsible for obtaining a City Fire Hydrant Permit for construction water, prior to construction. The permit for temporary construction water shall be obtained at the City Public Works office located at 1951 South River Road; Phone: (916) 617-4850. The Contractor shall be held to all responsibilities and conditions of the Fire Hydrant Permit and the Hydrant Meter Policy. The Fire Hydrant Permit will be provided to the Contractor free of charge but there will be a refundable \$1,725 deposit required. The temporary water permit, obtained prior to construction, may be charged against the project Work Order Number. All City equipment issued to the Contractor under the Fire Hydrant Permit shall be returned to the City prior to issuance of the Contract final payment. All costs for repair and/or replacement of any lost or damaged City equipment, including repair of hydrants damaged as a result of use by the Contractor, shall be deducted from the Contractor's final payment.

Compensation for any required fees or costs, and adherence to all specified requirements is included in the payment for Develop Water Supply.

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12 TEMPORARY TRAFFIC CONTROL

Replace section 12-1.04 with:

Payment for flagging is included in the payment for traffic control system.

Replace section 12-3.11D with:

12-3.11D Payment

Payment shall be at the lump sum bid and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing construction area signs required for the direction of public traffic through or around the work and for erecting or placing, maintaining (including covering and uncovering as needed) and, when no longer required, removing construction area signs at locations shown on the traffic control plans.

Full compensation for furnishing, erecting, maintaining and removing any additional construction area signs ordered by the Engineer will be considered as included in the lump sum price paid for construction area signs and no additional compensation will be allowed therefor.

Replace section 12-3.20 with:**12-3.20 TEMPORARY BARRIER SYSTEMS****12-3.20A General****12-3.20A(1) Summary**

Section 12-3.20 includes specifications for placing, maintaining, repairing, and removing temporary barrier systems.

Temporary barrier system consists of:

1. New or undamaged used interconnected barrier segments
2. Segment connection hardware
3. Stakes and anchor bolts

12-3.20A(2) Definitions

approach zone: Area immediately upstream of the work area and buffer space.

clear area width: Minimum width throughout the length of the barrier system that must be maintained clear of obstructions, objects, and work resources during non-working hours. The width is measured perpendicular from the non-traffic side toe.

departure zone: Area past the work area and the trailing end of the construction area.

height differential: May be an excavation, a downward slope greater than 4:1, or a difference in elevation. The height differential is measured down from the top of pavement.

set back distance: Space measured between the closest toe of temporary barrier and the edge of traveled way for each direction of traffic.

12-3.20A(3) Submittals

Submit as informational submittal for each type of temporary barrier system:

1. Certificate of compliance.
2. Manufacturer's installation instructions except for temporary concrete barriers with loop and pin and temporary concrete barriers with cross bolt.
3. Manufacturer's concrete QC test results and daily production log of precast concrete activities, under section 90-4. QC test results must include the concrete mix design number and barrier stamped ID.

Submit test reports for cross bolts that certify compliance with the applicable ASTM requirements. The test reports must be from a laboratory that is accredited to International Standards Organization/International Electrotechnical Commission 17025 by the American Association for Laboratory Accreditation (A2LA) or the ANSI-ASQ National Accreditation Board.

Submit a signed manufacturer's replacement evaluation report within 10 days of damage to a temporary steel barrier system.

12-3.20A(4) Quality Assurance**12-3.20A(4)(a) General**

Temporary barrier systems must comply with MASH Test Level 3 except for Type K temporary railing.

Except for temporary concrete barriers with loop and pin and temporary concrete barriers with cross bolt, temporary barrier systems must:

1. Be on the Authorized Materials List for highway safety features
2. Comply with the manufacturer's drawings shown on the Department's Division of Safety Programs website and the manufacturer's installation instructions

If a discrepancy exists, governing ranking in descending order is:

1. These specifications
2. Manufacturer's drawings

3. Manufacturer's installation instructions

QC sampling, testing, and inspection personnel must have an ACI Concrete Field-Testing Technician, Grade 1 certification.

Temporary concrete barrier segments must:

1. Comply with the requirements for tier 3 precast concrete in section 90-4
2. Be fabricated at a plant on the Authorized Facility Audit List

Concrete must be sampled and tested as shown in the following table.

Concrete QC Tests		
Quality characteristic	Test method	Minimum testing frequency
Compressive strength	ASTM C172/C172M, ASTM C31/C31M, and ASTM C39/C39M	Once per 300 cu yd of concrete cast, or every day of casting, whichever is more frequent
Slump	ASTM C143/C143M	
Temperature at time of mixing	ASTM C1064/C1064M	
Density	ASTM C138	Once per 600 cu yd of concrete cast or every 7 days of batching, whichever is more frequent
Air content	ASTM C231/C231M or ASTM C173/C173M	If concrete is air entrained, once for each set of cylinders, and when conditions warrant

A daily production log of precast concrete activities must be maintained under section 90-4.01C(4).

12-3.20A(4)(b) Quality Control

Replace damaged temporary concrete barrier segments with exposed reinforcing steel or concrete spalls 1-1/2 inches in depth and 4 inches in width or greater. Repair minor damage under section 51-1.03F(2), for temporary concrete barriers with loop and pin and temporary concrete barriers with cross bolt.

Replace damaged temporary steel barrier segments with permanent bends, tearing, or buckling as described in the signed manufacturer's replacement evaluation report.

Realign temporary barrier system within 2 days of impact or displacement when displaced more than 3 inches except when the temporary barrier system is displaced into a traveled lane realign immediately.

12-3.20B Materials**12-3.20B(1) General**

Temporary barrier segment must:

1. Be a minimum 31-1/2 inches in height
2. Have at least two lifting holes
3. Be designed to be used with temporary traffic screen when required

Temporary barrier segment may have your name or logo on each barrier segment. The name or logo must be no more than 4 inches in height and must be located no more than 12 inches above the bottom of the barrier segment.

12-3.20B(2) Temporary Concrete Barriers**12-3.20B(2)(a) General**

Temporary concrete barrier segment must:

1. Be precast concrete with a minimum 5,000-psi compressive strength, except for Type K Temporary Railing.
2. Have reinforcement steel that complies with section 52.
3. Have a finished surface that complies with section 51-1.03F(2).

4. Include the manufacturer's name, lot number, and month and year of manufacture stamped on the top of each barrier segment except for Type K temporary railing. The stamped information must be:
 - 4.1. No more than 6 inches in height
 - 4.2. From 3/16 to 1/4 inch in depth
 - 4.3. Centered on the top width of the barrier segment
5. Use one of the following segment connections:
 - 5.1. Loop and pin
 - 5.2. "J" hook
 - 5.3. Cross bolt
6. Comply with the tolerances shown in the following table:

Precast Barrier Tolerances

Dimension	Tolerance(±)
Length (in)	1
Insert placement (in)	1/2
Horizontal alignment (in)	1/8 per 10 feet of length
Deviation of ends (in):	
Horizontal skew	1/4
Vertical batter	1/8 per foot of depth

Reinforcement steel must:

1. Comply with ASTM A615 or ASTM A706, Grade 60
2. Be galvanized under section 52-3, when required

Combinations of reinforcing steel and welded wire reinforcement are allowed. Welded wire reinforcement must comply with ASTM A1064.

Stake must:

1. Comply with ASTM A36/A36M-14 or ASTM A529-14, Grade 50
2. Be 1-1/2 inches in diameter and 36 inches long, except "J" Hook must be 48 inches long
3. Have a 1/2-by-3-1/2-by-3-1/2-inch plate welded 2 inches down from the upper end using a 3/8-inch fillet weld under AWS D1.1 or D1.4

Anchor bolt must:

1. Be a bolt or threaded rod 1-1/8 inches in diameter
2. Comply with ASTM A307
3. Include a 1/2-by-3-1/2-by-3-1/2-inch plate washer:
 - 3.1. With a 1-3/8-inch-diameter hole in the center
 - 3.2. Complying with ASTM A36/A36M
 - 3.3. Galvanized post fabrication under section 75-1.02B

Threaded rod must include a nut complying with ASTM A563.

Anchor steel plate must:

1. Be 1/2 inch thick
2. Comply with ASTM A572, Grade 50
3. Be galvanized post fabrication under section 75-1.02B

Chemical adhesive must be on the Authorized Materials List for chemical adhesives and must be for a threaded rod at least 1 inch in diameter.

12-3.20B(2)(b) Temporary Concrete Barriers with Cross Bolt

Cross bolt hardware includes:

1. Cross bolt

2. Nut complying with ASTM A563
3. Hardened washer complying with ASTM F436, Type 1
4. Plate washer complying with ASTM A36/A36M and galvanized post fabrication under section 75-1.02B

Cross bolt must:

1. Be a 7/8-inch bolt or threaded rod and comply with one of the following:
 - 1.1. HS threaded rod ASTM A193, Grade B7
 - 1.2. HS threaded rod ASTM A449, Type 1
 - 1.3. HS nonheaded anchor bolt ASTM F1554, Grade 105, Class 2A
2. Have a permanent grade symbol and manufacturer's identifier

12-3.20B(2)(c) Temporary Concrete Barriers with Loop and Pin

12-3.20B(2)(c)(i) General

Not Used

12-3.20B(2)(c)(ii) Temporary Barrier Systems CAL F-23

Connecting loop must:

1. Be a steel bar 3/4 inch in diameter
2. Comply with ASTM A36/A36M, cold roll
3. Be galvanized after fabrication

Connecting pin must:

1. Comply with ASTM A449
2. Be forged, no welds
3. Be 1 inch in diameter and a minimum 30-1/4 inches long
4. Be galvanized under ASTM F2329 and A153

12-3.20B(2)(c)(iii) Type K Temporary Railings

Connecting pin must comply with ASTM A307, be 1-1/4 inch in diameter, and be a minimum 26 inches long. A round bar of the same diameter and length may be substituted for the connecting bolt. The round bar must:

1. Comply with ASTM A36/A36M
2. Have a 3-inch-diameter, 3/8-inch-thick plate welded on the upper end using a 3/16-inch fillet weld

Stake must:

1. Comply with ASTM A706, Grade 60
2. Be 1 inch in diameter and 24 inches long
3. Have a 2-3/4-inch-diameter, 1/2-inch-thick plate, welded 1 inch down from the upper end using a 3/8-inch fillet welds under AWS D1.1 or D1.4

Anchor bolt must:

1. Be a threaded rod, 1 inch in diameter and 15-1/2 inches long
2. Comply with ASTM A307
3. Include a nut complying with ASTM A563
4. Include a 3/8-by-2-1/2-by-3-inch plate washer:
 - 4.1. With a 1-1/8-inch-diameter hole in the center
 - 4.2. Complying with ASTM A36/A36M
 - 4.3. Galvanized post fabrication under section 75-1.02B

12-3.20B(2)(d) Temporary Concrete Barriers with "J" Hook

"J" hook must:

1. Comply with ASTM A36/A36M
2. Be 3/8-inch-thick steel plate

3. Be a minimum 18 inches in height

Anchor hardware must include:

1. Anchor bolt insert 1 inch in diameter and 6 inches long
2. Hex head bolt 1 inch in diameter with a minimum length of 11 inches plus thickness of asphalt overlay
3. 3/8-by-3-by-3-inch plate washer
4. Retainer ring

12-3.20B(3) Temporary Steel Barriers

Temporary steel barrier segment must:

1. Be galvanized steel.
2. Have a joint connection.
3. Include permanent identification information with no more than 6 inches in height and 12 inches in length and centered on the top width of the segment. The identification information must include:
 - 3.1. Manufacturer's name
 - 3.2. Serial number
 - 3.3. Lot number
 - 3.4. Month and year of manufacture

Temporary steel barrier 19-foot segment must be filled to a depth of 11-13/16 inches with concrete ballast.

12-3.20C Construction

12-3.20C(1) General

Install the minimum length of application for temporary barrier systems, including:

1. Approach zone
2. Work area
3. Departure zone

Clean temporary barrier segments at time of installation and at least every 6 months thereafter.

Install temporary barrier systems based on the requirements shown in the following table:

Minimum Clear Area Width

Barriers	Configuration	Height differentials 3 feet or less (ft)	Height differentials greater than 3 feet up to 8 feet (ft)	Edge of deck or height differentials greater than 8 feet (ft)	Fixed objects, falsework members, or temporary supports ^a (ft)
10-foot & 30-foot temporary concrete barrier with cross bolt	Freestanding	1	2	5	5
	3 stakes or anchor bolts per segment traffic side	1	1	2	3
20-foot temporary concrete barrier with cross bolt	Freestanding	1	2	5	5
	4 stakes or anchor bolts per segment traffic side	1	1	2	3
12-foot temporary concrete barrier CAL F-23	Freestanding	4	5	8	8
	3 stakes or anchor bolts per segment traffic side	1	1	2	3
20-foot temporary concrete barrier CAL F-23	Freestanding	4	5	8	8
	4 stakes or anchor bolts per segment traffic side	1	1	2	3
12.5-foot temporary concrete barriers with "J" hook	Freestanding	3	4	8	7
	3 stakes per segment traffic side	1	1	2	3
	2 anchor bolts per segment traffic side	1	1	2	3
20-foot temporary concrete barriers with "J" hook	Freestanding	3	4	8	7
	4 stakes per segment traffic side	1	1	2	3
	3 anchor bolts per segment traffic side	1	1	2	3
50-foot temporary steel barriers	Staked or anchored at both ends only	6	7	9	10
	Staked or anchored every 250 feet	5	6	8	9
	Staked or anchored every 33 feet	1	1	3	4
19-foot temporary steel barriers	Freestanding	4	5	7	8
12-foot-9-inch temporary steel barriers	Staked every 30 feet	1	2	4	5

20-foot Type K temporary railings (NCHRP 350)	Freestanding	2	3	8	7
	2 stakes or 2 anchor bolts per segment traffic side	1	1	3	4
	4 stakes or 4 anchor bolts per segment	N/A	N/A	3	3

^aThe minimum clear area width to a falsework or temporary support footing can be 2 feet less than the clear area width shown. Measure clear area width to the footing edge closest to traffic.

Place temporary barrier systems on concrete or asphalt concrete pavement.

When required, stake temporary barrier systems placed on asphalt concrete pavement.

When required, anchor temporary barrier systems placed on concrete pavement. For bridge decks, confirm the anchor will not penetrate closer than 1-1/2 inches from the bottom of the deck before placement. When temporary barrier is not shown, request the Engineer to verify the bridge deck thickness.

For installations on concrete pavement, drill holes and bond anchor bolts, threaded rods, or dowels under section 51-1.03E(5). Do not drill the top of supporting beams or girders, bridge expansion joints, or drains.

Install stakes and anchor bolts so the heads do not project above the top of the temporary barrier pocket profile.

Offset the approach zone of temporary barrier systems a minimum of 15 feet from the edge of an open traffic lane and stake or anchor barrier ends as shown. Taper the temporary barrier approach zone toward the edge of the open traffic lane at the rate shown in the following table:

Temporary Barrier System Taper Rate	
Posted speed (mph)	Rate ^a
0 to 45	10:1
46 to 60	15:1
61 to 65	20:1

^aRate is longitudinally to transversely with respect to the edge of the traveled way

When a 15-foot minimum tapered offset cannot be achieved, offset temporary barrier systems the maximum distance available, place the first segment at the approach end parallel to the road, and install an authorized temporary crash cushion system at each barrier approach end. Ensure the temporary barrier approach zone length is a minimum:

1. 60 feet on facilities with a posted speed of 45 mph or less
2. 100 feet on facilities with a posted speed greater than 45 mph

Place a minimum 60 feet temporary barrier departure zone length.

Install a reflector on the top or face of barrier segments placed within 10 feet of a traffic lane. Space reflectors at approximately 20-foot intervals. Apply adhesive for mounting the reflector under the reflector manufacturer's instructions.

Install a Type P marker panel complying with section 82 at:

1. Each end of a temporary barrier system placed adjacent to a two-lane, two-way highway
2. The end facing traffic for a temporary barrier system installed adjacent to a one-way roadbed
3. The end of the skew nearest the traveled way when a temporary barrier system is placed on a skew

Maintain a minimum height of 31-1/2 inches above pavement for temporary barrier systems. For paving activities adjacent to temporary barriers, do not pave within 2 feet of the barrier segments unless authorized. For paving under the temporary barrier, remove and reset the barrier.

Remove temporary barrier systems when no longer required for the work. Remove stakes and anchor bolts so that minimal damage is done to pavement.

After removing the temporary barrier systems:

1. Restore the area to its previous condition or construct it to its planned condition if temporary excavation or embankment was used to accommodate the temporary barrier.
2. Remove all threaded rods or dowels to a depth of at least 1 inch below the top of concrete pavement. Fill the resulting holes with mortar under section 51-1 except cure the mortar by the water method or by the curing compound method using curing compound no. 6.
3. Repair damaged asphalt pavement by providing a clean, smooth edge around the damaged area. Repair any heaving caused by stake removal to provide a uniform surface. Remove loose debris and use compressed air to clean out the stake hole. Comply with manufacturer's requirements except fill the stake hole with grout to existing pavement elevation under section 51-1.

If the Engineer orders a lateral move of a temporary barrier system and repositioning is not shown, the lateral move is change order work except for work area access, clear area width compliance, or because of your means and methods to perform the work.

12-3.20C(2) Temporary Concrete Barriers

12-3.20C(2)(a) General

Before placing temporary barrier systems on the job site and after each described relocation, paint the exposed surfaces of the segments with white paint complying with specifications for acrylic emulsion paint for exterior masonry.

Place and maintain the abutting ends of segments in alignment without substantial offset from each other.

For freestanding temporary barrier systems, you may extend the taper by 60 feet beyond the required 15-foot tapered offset instead of anchoring the barrier ends.

Install stakes or anchors as shown and maintain a minimum 1-foot set back distance on both sides of barrier, when temporary barrier systems are placed with traffic on both sides.

12-3.20C(2)(b) Temporary Concrete Barriers with Cross Bolt

Intermix segments of different lengths within a temporary barrier system when necessary.

For temporary barrier systems placed on a curved layout, maintain the minimum curve radius shown in the following table:

Minimum Curve Radius	
Segment length (ft)	Curve radius (ft)
10	125
20	265
30	400

12-3.20C(2)(c) Temporary Concrete Barriers with Loop and Pin

12-3.20C(2)(c)(i) General

Not Used

12-3.20C(2)(c)(ii) Temporary Concrete Barriers CAL F-23

Intermix segments of different lengths within a temporary barrier system when necessary.

For temporary barrier systems placed on a curved layout, maintain the minimum curve radius shown in the following table:

Minimum Curve Radius

Segment length (ft)	Curve radius (ft)
12	100
20	165

12-3.20C(2)(c)(iii) Type K Temporary Railings

Do not install Type K temporary railings on projects advertised after December 31, 2026.

Install a minimum 160 feet of Type K temporary railing.

Excavate and backfill under section 19-3.

Do not compact earth fill placed behind Type K temporary railings in a curved layout.

Place temporary barrier systems on a firm, stable surface. Grade the area to provide a uniform bearing surface throughout the entire length of the system.

12-3.20C(2)(d) Temporary Concrete Barriers with "J" Hook

When temporary barrier systems are placed with traffic on both sides, install on each side:

1. 2 anchors or stakes for 12.5-foot segments
2. 3 anchors or stakes for 20-foot segments

12-3.20C(3) Temporary Steel Barriers**12-3.20C(3)(a) General**

Install temporary barrier systems under manufacturer's instructions.

12-3.20C(3)(b) 50-Foot Temporary Steel Barriers

Use 50-foot temporary steel barriers with or without rubber pads.

Install a minimum 250 feet of 50-foot temporary steel barrier.

Maintain a minimum radius of 800 feet for segments placed on a curved layout. For tighter curves down to a 250-foot radius, contact the manufacturer before installation and provide manufacturer's written recommendation for the installation.

Stake or anchor segments every 33 feet and maintain a minimum 2-foot set back distance on both sides of barrier, when temporary barrier systems are placed with traffic on both sides.

12-3.20C(3)(c) 19-Foot Temporary Steel Barriers

Install a minimum 323 feet of 19-foot temporary steel barrier.

Maintain a minimum radius of 262 feet for segments placed on a curved layout.

Maintain a minimum 5-foot set back distance on both sides of barrier, when temporary barrier systems are placed with traffic on both sides.

12-3.20C(3)(d) 12-Foot-9-Inch Temporary Steel Barriers

Install a minimum 260 feet of 12-foot-9-inch temporary steel barrier.

Maintain a minimum radius of 755 feet for segments placed on a curved layout.

Stake or anchor segments and maintain a minimum 2-foot set back distance on both sides of barrier, when temporary barrier systems are placed with traffic on both sides.

12-3.20D Payment

The payment quantity for temporary barrier systems is [included in the payment for temporary traffic control system](#).

Replace section 12-3.22 with:**12-3.22 TEMPORARY CRASH CUSHIONS****12-3.22A General****12-3.22A(1) Summary**

Section 12-3.22 includes specifications for installing, repairing, replacing, maintaining, and removing temporary crash cushions.

12-3.22A(2) Definitions

Not Used

12-3.22A(3) Submittals

At least 10 days before installation, submit as informational submittal for each temporary crash cushion model:

1. Certificate of compliance
2. Two copies of the following:
 - 2.1. Manufacturer's installation and maintenance manual
 - 2.2. Department approved manufacturer's drawings from the Department's Division of Safety Programs website
3. Record of training provided by manufacturer for each person installing the temporary crash cushion

12-3.22A(4) Quality Assurance**12-3.22A(4)(a) General**

Not Used

12-3.22A(4)(b) Quality Control

Temporary crash cushion must be installed under the manufacturer's instructions by personnel trained by the manufacturer.

Keep a copy of the manufacturer's drawings, and installation and maintenance manual for each temporary crash cushion model at the job site during installation.

12-3.22B Materials**12-3.22B(1) General**

Temporary crash cushion must:

1. Be on the Authorized Materials List for highway safety features
2. Comply with MASH:
 - 2.1. Test Level 3 (TL-3) for a posted speed limit 45 mph or greater
 - 2.2. Test Level 2 (TL-2) for a posted speed limit less than 45 mph

Water-filled temporary crash cushion must:

1. Include all components required for attachment to temporary barrier or protected obstacle
2. Comply with the manufacturer's drawings shown on the Department's Division of Safety Programs website

Each sand-filled temporary crash cushion module must be:

1. Colored standard yellow with a black lid
2. Free from structural flaws and objectionable surface defects

Sand for filling module must:

1. Be commercial quality, washed concrete sand
2. Contain no more than 5 percent water under California Test 226
3. Be clean when placed in the module

12-3.22B(2) Temporary Crash Cushions TL-3

Temporary crash cushion TL-3 must:

1. Comply with MASH TL-3
2. Be one of the following:
 - 2.1. Water-filled temporary crash cushion gating, non-redirective system
 - 2.2. Sand-filled temporary crash cushion module array

12-3.22B(3) Temporary Crash Cushions TL-2

Temporary crash cushion TL-2 must:

1. Comply with MASH TL-2
2. Be one of the following:
 - 2.1. Water-filled temporary crash cushion gating, non-redirective system
 - 2.2. Sand-filled temporary crash cushion module array

12-3.22C Construction**12-3.22C(1) General**

When activities expose traffic to fixed obstacles, protect traffic from the obstacles with temporary crash cushions.

You may use NCHRP Report 350 compliant temporary crash cushions before December 31, 2026.

Install temporary crash cushions under the manufacturer's instructions before:

1. Starting activities requiring the crash cushions.
2. Opening to traffic lanes adjacent to the protected obstacles.

Temporary crash cushions must not impede the flow of traffic or encroach on the traveled way.

Attach a Type R or Type P marker panel to the front of temporary crash cushions if the closest point to the traveled way is within 12 feet of the traveled way. Fasten marker panels firmly to crash cushions with commercial quality hardware or by other authorized methods.

Maintain temporary crash cushions in place at each location, including when work is not in progress. Keep the area behind the temporary crash cushions clear of obstructions.

Repair damaged temporary crash cushions immediately. Remove and replace temporary crash cushions damaged beyond repair. Repair and replacement of temporary crash cushions damaged by traffic is change order work.

12-3.22C(2) Water-Filled Temporary Crash Cushions

Place temporary crash cushions and a minimum 20 feet of temporary barrier at a parallel 2-foot offset from edge of traveled way.

Install temporary crash cushions adjacent to a:

1. Barrier at an offset distance 1 to 2 feet or 7 feet or greater from the barrier
2. Dike or curb at an offset distance 0 to 4 feet or 7-1/2 feet or greater from the dike or curb

12-3.22C(3) Sand-Filled Temporary Crash Cushions

Do not use sand-filled temporary crash cushions for permanent installations.

Use the same type of sand-filled modules for each array. Fill each sand-filled module with sand under the manufacturer's instructions.

Securely fasten the top edge of a seal to the wall of the sand-filled module with a continuous strip of heavy-duty tape, when a seal is required.

You may place sand-filled temporary crash cushion modules on movable pallets or frames complying with the dimensions shown. The pallets or frames must provide a full-bearing base beneath the modules. Do not move the modules and supporting pallets or frames by sliding or skidding along the pavement or bridge deck.

Attach a Type R marker panel such that the top of the panel is 1 inch below the module lid. Attach a Type P marker panel such that the bottom of the panel rests upon the roadway surface or pallet surface when used.

You may remove sand-filled modules during the work shift for access to the work area if the exposed fixed obstacle is 15 feet or more from the nearest lane carrying traffic. Reset the modules before the end of the work shift.

A lateral move of a temporary crash cushion module is change order work if ordered and the repositioning is not shown.

Remove sand-filled temporary crash cushion modules, including sand, pallets or frames, and marker panels, at Contract acceptance.

12-3.22D Payment

The payment for temporary crash cushions is included in the payment for temporary traffic control system.

Add to the beginning of section 12-3.32C:

Place PCMSs at the locations shown and in advance of the 1st warning sign for each:

1. Stationary lane closure
2. On-ramp closure
3. Shoulder closure

Add between the 9th and 10th paragraphs of section 12-3.32C:

Start displaying the message on the sign ten calendar days (10) before closing the lane or shoulder or when directed by the Engineer.

Replace section 12-3.32D with:

12-3.32D Payment

The payment for portable changeable message signs is included in the payment for temporary traffic control system.

Replace section 12-4.02A(3) with:

12-4.02A(3) Submittals

Submit to the Engineer for review and approval a traffic handling and detour plan showing traffic control measures for vehicles, pedestrians and bicycles affected by the construction work. For work within the City of West Sacramento, traffic handling and detour plans shall be submitted to the City of West Sacramento staff for review and approval. For emergency purposes, the responsible person in charge of the work must be reachable by phone 24 hours a day during the progress of the work. A 24-hour phone number shall be indicated on the permit application.

The Contractor must submit for review and approval the following items:

1. Construction Sequencing Plan – detailing the proposed construction staging and proposed closures including limits, durations, and dates. All closures shall be clearly indicated in the project schedule.
2. Detour Plan – detailing the rerouting of pedestrian, bicycle, and vehicular traffic during any proposed closures.

3. Traffic Control Plan – detailing how pedestrian, bicycle, and vehicular traffic will be routed through active construction areas.
4. Temporary Traffic Signal Plan – detailing how pedestrian, bicycle, and vehicular traffic will be routed through a signalized intersection within active construction areas.

The submitted plans shall cover all proposed phases of work. Each plan shall be submitted to the Engineer, and within the City of West Sacramento, to City staff for review and approval. The contractor shall make all requested modifications to these plans and no work affected by these plans shall begin until the plans have been approved.

Traffic Control Plan must be prepared in accordance with Section 6-10 of the Standard Specifications. Revisions to the plan shall be submitted five (5) days prior to work. Within the City of West Sacramento, a site specific Traffic Control Plan shall be submitted to the Engineer and City of West Sacramento staff for review. A copy of the Traffic Control Plan shall be available on site at all times. The Traffic Control Plan shall be developed within the following parameters:

1. No Work will be allowed if the Contractor does not adhere to these traffic control guidelines.
2. The Contractor shall provide continuous business access (for loading operations, pedestrian traffic and safety vehicles) during the businesses' hours of operations. If two driveways access a single business, one driveway must remain open at all times. If three driveways access a single business, two driveways must remain open at all times.
3. Where a commercial or residential driveway being the sole means of access to the affected property is less than 20 feet wide at the apron or the path of ingress and egress is affected by a fence, gate, planter, or other object as to render the path of travel less than 20 feet across, two phases of construction may not be adequate to allow for continued access to the property. Construction of these driveways may need to take place at weekends or outside normal business hours so as not to disturb the property owner/ tenant. In lieu of weekend and/or construction during non-business hours a signed acknowledgement from the affected property owner/tenant stating that they are aware that their driveway will be out of service for a maximum of 8 hours during the work shift and that their driveway will be accessible by the end of shift by the use of construction plating or a bridge during the concrete curing process, and as approved by the engineer. Regardless of method, notice must be given to the property owner/tenant at least 10 business days in advance of any proposed work at that location. Final approval of any method and agreement for securing access to property is by the engineer.
4. Where a parking lot is unidirectional, and the construction of driveways will impact the traffic flow and ability of the public to utilize the parking lot as designed the contractor shall provide temporary access so as to make the parking lot function as intended. At the discretion of the engineer the contractor may elect to create temporary striping in the parking lot to facilitate the temporary path of travel during construction. The parking lot will be returned to its pre-construction configuration once the driveways are open to traffic at the contractor's expense.
5. Properties where a fence shall be relocated, a temporary fence shall be installed to secure the property at all times. The Contractor will be responsible for the cost of installing a temporary fence as shown elsewhere in the Contract bid items.
6. At least one lane of vehicular traffic must be maintained in each direction at all times unless otherwise approved by the Engineer. The Contractor shall use temporary delineators to close vehicular traffic lane. Local access to businesses shall be provided at all times.
7. Working hours shall be between 7:00 AM and 5:00 PM Monday through Friday, unless otherwise approved by the Engineer.
8. In the City of West Sacramento working hours shall be between 8:00 AM and 5:00 PM Monday through Friday, unless otherwise approved by the Engineer.
9. Working hours for in water construction activities shall be between 7:00 AM and 5:00 PM Monday through Friday, May 1st and November 30th.
10. Weekend work from 7:00 AM to 6:00 PM may be approved by the Engineer. Inspection and material testing during weekend will be at the cost of the Contractor.
11. The Contractor shall submit for approval, a written request to perform weekend work a minimum of two (2) weeks prior to the weekend dates. If weekend work is approved, the additional cost of inspection shall be borne by the Contractor.
12. The Contractor shall furnish, install temporary stripes and maintain temporary construction warning signs, lighting, flaggers, barricades, striping and other devices necessary to safeguard the general public and the

work, and to provide for the safe and proper routing of all vehicular and of pedestrian traffic within and through the limits of the projects during the construction. The requirement shall apply continuously and shall not be limited to normal working hours.

13. The Contractor shall maintain existing electrical facilities and traffic and public safety in accordance with Section 34 of the Standard Specifications and these Special Provisions.
14. Except as specified elsewhere in these Special Provisions, commercial driveways shall remain open at all times. The Contractor shall schedule the commercial driveways to be poured in two phases unless more than one driveway is available to the property. The Contractor shall coordinate the driveway closure with property owners 5 calendar days in advance.
15. All work within public streets and/or roadway right-of-way shall be done in an expeditious manner so as to cause as little inconvenience to the traveling public as possible. Skid-resistant steel plates or other approved methods shall be used to cover all open excavations in the roadway during non-working hours.
16. Loading access to businesses must be maintained at all times. Pedestrian Access with ADA compliant path of travel must be provided and maintained.
17. All work is to be done in accordance with City of Sacramento's and the City of West Sacramento's noise ordinances, per Section 6 of the City Standard Specifications and Section 5 of the City of West Sacramento's Division III General Conditions.
18. Lane closures shall be in conformance with an approved traffic control plan.
19. Designated haul routes must be submitted to the City of Sacramento and City of West Sacramento for approval.
20. Placement and removal of the temporary traffic stripes (tape) and pavement markings (tape) required in each stage of construction shall be considered part of this item and no additional compensation will be allowed therefor.
21. Removal of any existing conflicting pavement stripes or makings shall be considered part of this item and no additional compensation will be allowed therefor.
22. Relocation of roadway signs from their current location to a temporary location needed for stage construction and all sign relocations needs during construction including temporary barricades shall be considered part of this item and no additional compensation will be awarded therefor.

Replace section 12-4.02A(4) with:

The contractor shall adhere to guidelines as stated in Section 12.20.030 of Title 12 of the Sacramento City Code pertaining to Traffic Control Plan – Requirements and shall conform to the current edition of the California MUTCD. Particular attention is directed to Chapter 6D – Pedestrian and Worker Safety and Chapter 6F – Temporary Traffic Control Zone Devices, Section 6F.68 – Detectable Edging for Pedestrians.

Replace section 12-4.02C(5) with:

12-4.02C(5) Public Access

Access to businesses must be maintained at all times. The pedestrian walkways fronting the businesses must be staged so pedestrian access is maintained to the businesses as construction is occurring. Pedestrian access to businesses must meet all applicable ADA requirements. The contractor developed traffic handling plan must include details for how this access will be maintained.

All work within public streets and/or roadway rights-of-way shall be done in an expeditious manner and cause as little inconvenience to the traveling public as possible. Vehicles, bicycles, and pedestrians must be allowed to pass at all times except during an Engineer approved closure.

The Contractor shall not block the movement of pedestrian or bicycle traffic unless as part of an Engineer approved closure. The Contractor shall provide for pedestrian and bicycle traffic by phasing construction operations or by providing alternative pedestrian and bicyclist access through or adjacent to construction areas. The contractor must submit for review and approval a traffic handling plan which includes details for the provision of pedestrian and bicycle access.

Proper advance notice signage with reasonable detours shall be installed and maintained through all phases of construction. At no time shall pedestrians be diverted into a portion of the street used for vehicular traffic or on to private property unless adequate lane closure signage is in place. Minimum allowable pedestrian and bicycle access shall consist of four-foot (4') wide bridges across trenches and four-foot (4') wide passageways through construction areas. Hand railings for pedestrians shall be provided when required by Cal/OSHA Regulations or the Americans with Disabilities Act (ADA) on each side of each bridge or passageway to protect pedestrians

12-4.02C(3)(m) City Street Closure Hour Charts and City Street Lane Requirement Charts

Chart No. <u>M1</u> <u>City Street Closure Requirements and Hours of Work</u>																											
Location: <u>City of Sacramento</u> <u>Jibboom St</u>														Direction: <u>NB/SB</u>													
Closure limits: <u>Between Railyards Blvd and I St Bridge</u>																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon– Thu	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Fri	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Sat	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Sun	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Legend:																											
<u>C</u>	Street may be closed.																										
<u>N</u>	No <u>lane closure</u> is allowed.																										
REMARKS: <u>See Detour Plans for roadway closures.</u>																											

Chart No. <u>M2</u> <u>City Street Closure Requirements and Hours of Work</u>																											
Location: <u>City of Sacramento St</u>														Direction: <u>EB/WB</u>													
Closure limits: <u>Between 3rd St and 4th St</u>																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon– Thu	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>			
Fri	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>			
Sat	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>			
Sun	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>			
Legend:																											
<u>C</u>	Street may be closed.																										
<u>N</u>	No <u>lane closure</u> is allowed.																										
REMARKS: <u>See Detour Plans for roadway closures.</u>																											

Chart No. M3 City Street Lane Requirements and Hours of Work																											
Location: City of Sacramento I St														Direction: EB/WB													
Closure limits: Between 4th St and 5th St.																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon–Thu	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2	2	2			
Fri	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2	2			
Sat	2	2	2	2	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2			
Sun	2	2	2	2	2	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	2	2	2			
Legend:																											
2	Provide at least 2 city street lanes open in the direction of travel.																										
N	No lane closure is allowed.																										
REMARKS:																											

Chart No. M4 City Street Lane Requirements and Hours of Work																											
Location: City of Sacramento 5th St														Direction: NB/SB													
Closure limits: Between J St and I St.																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon–Thu	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2	2	2	2		
Fri	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2	2	2			
Sat	2	2	2	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2	2			
Sun	2	2	2	2	2	2	2	2	2	N	N	N	N	N	N	N	N	N	N	N	N	2	2	2			
Legend:																											
2	Provide at least 2 city street lanes open in the direction of travel.																										
N	No lane closure is allowed.																										
REMARKS:																											

Chart No. <u>M5</u> <u>City Street Lane Requirements and Hours of Work</u>																											
Location: <u>City of Sacramento J St</u>														Direction: <u>EB/WB</u>													
Closure limits: <u>Between I-5 SB and 3rd St.</u>																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon–Thu	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>			
Fri	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>			
Sat	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>1</u>	<u>1</u>			
Sun	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>			
Legend:																											
1	Provide at least 1 city street lane open in the direction of travel.																										
N	No <u>lane closure</u> is allowed.																										
REMARKS:																											

Chart No. <u>M6</u> <u>City Street Lane Requirements and Hours of Work</u>																											
Location: <u>City of West Sacramento 2nd St</u>														Direction: <u>EB/WB</u>													
Closure limits: <u>Between 3rd and B St.</u>																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon–Thu	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>			
Fri	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>			
Sat	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>			
Sun	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>			
Legend:																											
C	Street may be closed.																										
N	No <u>lane closure</u> is allowed.																										
REMARKS:																											

Chart No. <u>M7</u> <u>City Street Lane Requirements and Hours of Work</u>																											
Location: <u>City of West Sacramento C St</u>														Direction: <u>EB/WB</u>													
Closure limits: <u>Between 3rd and 2nd St.</u>																											
Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Mon–Thu	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Fri	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Sat	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Sun	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>C</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>C</u>	<u>C</u>	<u>C</u>			
Legend:																											
<u>C</u>	Street may be closed.																										
<u>N</u>	No <u>lane closure</u> is allowed.																										
REMARKS:																											

13 WATER POLLUTION CONTROL

Replace the section 13-1.01C(5) with:

13-1.01C(5) Erosion, Sediment, and Pollution Control Plan

Prepare and submit an erosion, sediment and pollution control plan (ESC Plan) to the Engineer for review, per Section 16 of the Standard Specifications. The submittal shall include a description of all erosion, sediment and pollution control BMPs proposed to be used to prevent sediment and other sources of pollution from entering the City of Sacramento's and the City of West Sacramento's storm drain system as well as a site plan showing their placement. The ESC Plan shall be submitted a minimum of 48 hours prior to start of the work. The Contractor will not be allowed to begin work until an accepted ESC Plan is on file with the Engineer. The erosion, sediment and pollution control plan shall be updated as necessary and re-submitted to the Engineer.

Replace the 1st paragraph of section 13-1.01D(2) with:

Comply with the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit issued to the City of and the City's Erosion and Sediment and Pollution Control and the Stormwater Management and Discharge Control Ordinances. Failure to comply with the requirements of the General Permit could result in significant daily fines. General Permit coverage is obtained by certifying and filing a Notice of Intent (NOI) with the State Board. The Contractor will be responsible for filing the NOI and paying applicable fees. The General Permit also requires inspection of erosion and sediment control measures before, during, and after storm events.

Per City Code Sections 15.88, 13.16 and 1.28, the Contractor shall be subject to Notices of Violation (NOVs) resulting in possible Stop Work Orders and Administrative Penalties of up to \$4,999 per day for non-compliance of this section of the Special Provisions.

Per the State's Porter Cologne Water Quality Act, the Contractor shall also be subject to inspection by Staff from the Central Valley Regional Water Quality Control Board who have the authority to issue Notices of Violation (NOVs) and Penalties of up to \$10,000 per day for non-compliance. The Contractor shall be liable for

The City reserves the right to take corrective action and withhold the City's costs for corrective action from progress payments or final payment in accordance with Section 7, Retention of Sums Charged against the Contractor, of the Agreement.

Any fines, including third-party claims, levied against the City as a result of Contractor's non-compliance are the Contractor's sole responsibility and will be withheld from progress payments or final payment in accordance with Section 7, Retention of Sums Charged against the Contractor, of the Agreement.

Payment for all water pollution control facilities, devices and measures required to implement the SWPPP is included in lump sum price for Prepare Stormwater Pollution Prevention Plan.

The receiving water for this project is [Sacramento River](#).

Not Used

Payment for preparing storm water pollution prevention plan is the lump sum price and shall full compensation for furnishing all labor, materials, tools, equipment, incidentals for doing all the work involved in developing and implementing a SWPPP, including fees, renewal costs, providing a WPC manager, storm water sampling and analysis days, Final Closeout Report, and Storm Water Annual Reports, conducting water pollution control training, and monitoring, inspecting and correcting water pollution control practices, plan as specified in these Special Provisions and as directed by the Engineer.

Compensation for any required fees or costs, and adherence to all specified requirements is considered as included in the lump sum price bid for Prepare SWPPP Plan and no additional compensation will be allowed therefor.

Job site management shall conform to Site Cleanup as specified in Section 16-3 of the City Standard Specifications.

Delete the second paragraph in section 13-5.04.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

14 ENVIRONMENTAL STEWARDSHIP

Add to the end of section 14-1.02:

An ESA exists on this project.

Before starting job site activities, install [temporary high-visibility fence](#) to protect the ESA and mark its boundaries.

Access to an ESA other than that described is prohibited.

Add to section 14-2.03B:

Archaeological monitoring areas within, near, or straddling the project limits are shown.

The designation is an identifier such as AMA-1. Define the longitudinal extent under *Post mile limits*. Replace *Post mile limits* with *Station numbers* if appropriate. If needed, define lateral extent and other special features as part of the description.

The locations of archaeological monitoring areas within, near, or straddling the job site are shown in the following table:

Archaeological Monitoring Areas	
Designation and description	Post mile limits

Add to the 1st paragraph of section 14-6.03A:

This project is within or near habitat for the regulated species shown in the following table:

Regulated Species

Purple Martin
Swainson's Hawk
Valley Elderberry Longhorn Beetle
Roosting Bat
Nesting Migratory Birds and Raptors
Western Pond Turtle

Replace item 1 in the list in the 2nd paragraph of section 14-6.03A with:

- Stop all work within a [100](#)-foot radius of the discovery except as shown in the following table:

Regulated species	Protective radius (feet)
Migratory Birds or Raptors	250

Within _____, implement the following protection measures:

- [No construction activity that results in ground disturbance, modification of the I Street Bridge approach structure, loud noises, and/or vibrations will be conducted within 100 feet of the edge of the purple martin colony during the purple martin nesting season \(March 15 to August 15\). In addition, no construction-related vehicles or machinery shall be operated or stored beneath the colony during this period or until a](#)

- qualified biologist determines that the purple martins have completed nesting and are no longer occupying the structure.
2. Install and maintain throughout construction high-visibility fencing at 20 feet minimum from each elderberry shrub's dripline and install sign every 50 feet along the high-visibility fence. The sign will contain the following:
This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.
 3. Establish and maintain a minimum non-disturbance buffer of 600 feet radius around the active Swainson's Hawk and White-Tailed Kite nests.
 4. Stop work in the area when the Western Pond Turtle is found during project activities until the turtle is able to move out of work area on its own.
 5. The removal of the approach structures associated with the I Street Bridge will take place outside of the breeding season for migratory birds and bats and will be conducted in the following manner to avoid and minimize direct harm and temporary disturbance to nesting birds and roosting bats.
 6. Establish and maintain non-disturbance buffer around bat roosts in cooperation with Designated Bat Biologist and CDFW during maternity season between April 15 and August 31 or hibernation season between October 15 and March 1.
 7. Exclusion devices shall be installed either (1) between approximately March 1 (or when evening temperatures are above 45°F and rainfall less than 1/4-inch in 24 hours occurs) and April 15, prior to parturition of pups; or (2) between September 1 and October 15 (or prior to evening temperatures dropping below 45°F and onset of rainfall greater than 1/2-inch in 24 hours). Specific exclusion devices may include one-way doors, lights and fans, foam or steel wool, or other site-specific methods determined in coordination with CDFW. The Designated Bat Biologist shall monitor the roost prior to exclusion to confirm that it does not support a maternity colony. If a maternity colony is or may be present, the roost shall be avoided until it is no longer active, or until the Designated Bat Biologist can confirm that no maternity colony is present.
 8. Remove or trim trees during the non-breeding season for tree-nesting migratory birds and raptors, and prior to periods when bats would be hibernating. If tree removal cannot be confined to this period, the project proponent will retain a qualified wildlife biologist with knowledge of the wildlife species that could occur in the project area to conduct the appropriate preconstruction surveys and establish no-disturbance buffers for sensitive wildlife species as described under measures for Swainson's hawk, nesting birds, and roosting bats.
 9. A qualified biologist provided by the Department to conduct environmental awareness training for construction crews before project implementation. The awareness training will be provided to all construction personnel and would brief them on the need to avoid effects on sensitive biological resources (e.g., native trees, natural communities of special concern, and special-status species habitats in and adjacent to the construction area). The education program will include a brief review of the special-status species with the potential to occur in the project area (including their life history, habitat requirements, and photographs of the species). The training will identify the portions of the project area in which the species may occur, as well as their legal status and protection.
 10. the contractor will vibrate all piles to the maximum depth possible before using an impact hammer. No more than 20 piles will be driven per day, and pile driving with an impact hammer will occur on no more than 75 individual days total during construction. During impact driving, the contractor will limit the number of strikes per day to the minimum necessary to complete the work and will limit the total number of hammer strikes to 16,000 strikes per day (i.e., 800 hammer strikes per pile, per day) for piles for the bridge piers and temporary trestles, and 20,000 strikes per day (i.e., 1,000 hammer strikes per pile, per day) for the piles for the bridge fender system. The smallest pile driver and minimum force necessary will be used to complete the work. During impact driving, the project proponent will require the contractor to use a bubble curtain or similar device, if feasible, to minimize the extent to which the interim peak and cumulative SEL thresholds are exceeded. No pile driving activity will occur at night, thereby providing fish with an extended quiet period during nighttime hours on days pile driving is being conducted for feeding and unobstructed passage. Sheet piles used for cofferdams will be installed and removed using a vibratory pile driver.
 11. Cofferdams will not be left in place over winter where they could be overtopped by winter/spring flows and when juveniles of listed species are most likely to be present in the construction area.
 12. Cofferdam dewatering and fish rescue/relocation from within cofferdams will commence immediately following cofferdam closure. All pumps used during dewatering of cofferdams will be screened according to CDFW and NMFS guidelines.

13. Install bubble curtains around piles during impact driving and proofing operations to dampen underwater sound shockwaves.
14. Conduct several dry or dead blows with the hammer initially to frighten fish away from the pile before the pile is driven or proofed with an impact pile driver. Implementation of several dry or dead blows with the hammer to initially frighten fish away is being proposed because the use of a cushioning block or similar feature would result in more strikes being needed to drive the piles, thereby resulting in a greater chance of exceeding the cumulative sound exposure levels (SELs) without significantly reducing peak SELs.
15. Whenever there has been downtime of 30 minutes or more without pile driving, Permittee shall reinitiate the pile driving with ramp-up procedures. For impact driving, an initial set of three strikes shall be made by the hammer at 40% energy, followed by a 1-minute waiting period, then two subsequent three-strike sets at 40% energy, with 1-minute waiting periods, before initiating continuous pile driving.
16. Prior to departure of vessels from their place of origin and before in-water construction equipment is allowed to operate within the waters of the Sacramento River, thoroughly inspect and remove and dispose of all dirt, mud, plant matter, and animals from all surfaces that are submerged or may become submerged, or places where water can be held and transferred to the surrounding water.

Replace section 14-7.04 with:

14-7.04 PALEONTOLOGICAL RESOURCES MITIGATION

Section 14-7.04 includes specifications for coordinating and working with a paleontological resources mitigation team provided by the Department.

The Department performs paleontological resources mitigation during construction activities involving subsurface disturbance under Pub Res Code § 5097.5 and the California Environmental Quality Act (CEQA). Do not start subsurface-disturbing activities until the paleontological mitigation team, consisting of a principal paleontologist and paleontological monitors, is present at the job site.

Fossils within or excavated from the highway remain the property of the Department.

Submit a schedule of subsurface-disturbing activities at least 15 days before starting job site activities. Submit an updated schedule at least 3 business days before implementing any changes.

Attend a preconstruction meeting with the paleontological resources mitigation team and the Engineer to establish procedures for coordination, cooperation, and worker safety during mitigation activities.

All of your personnel and subcontractors involved in subsurface-disturbing activities must complete 1 hour of training provided by the [Department's](#) mitigation team before working at the job site.

Within the project limits, do not perform subsurface-disturbing activities unless authorized. Notify the Engineer 15 days before starting subsurface-disturbing activities.

The paleontological mitigation team monitors and salvages fossils discovered during excavation.

The Engineer may order you to:

1. Divert or stop construction activities in the vicinity of fossils
2. Avoid disturbing an area pending the removal of fossils
3. Perform additional excavation
4. Modify an excavation to facilitate in-place stabilization of fossils by the mitigation team

Additional excavation and modification of an excavation to facilitate in-place stabilization of fossils if ordered are change order work.

Replace the 2nd paragraph of section 14-8.02 with:

Noise from job site activities must not exceed 86 dBA Lmax at 50 feet from the job site activity from _____ p.m. to _____ a.m. each day, and the noise level produced by the traffic on or by the construction activity can't exceed 52 dBA Leq interior noise levels in school facilities as defined under St & Hwy Code § 216.

See section 14-6.03A for additional noise level restrictions required by the permitting resource agencies. The lowest noise level restrictions apply.

The following activities may exceed this noise restriction during the hours and on the days shown in the following table:

Noise Restriction Exceptions

Activity	Hours		Days	
	From	To	From	Through
Service traffic-control facilities				
Service construction equipment				

Add to section 14-8.02:

Submit a noise control plan (NCP) to minimize construction noise including back up alarm.

Include the following information in the NCP:

1. List of the locations and construction activities to be monitored
2. Description of the construction activities and anticipated noise levels at these locations
3. Operating sound levels of construction equipment at specified distances and locations
4. Sound control measures to maintain noise levels within specified limits
5. Corrective actions if specified sound levels are exceeded
6. List of sound level meters and calibrators with current calibration certifications
7. Names, qualifications, and resumes of:
 - 7.1. Person who prepared NCP
 - 7.2. Personnel who will perform noise monitoring
8. Notification letter for residents that includes:
 - 8.1 Project location
 - 8.2 Project start and completion date
 - 8.3 Project contact person information
 - 8.4 Activities and duration of activities that could contribute to an increase in noise levels in the area

The NCP must be prepared by a qualified person that meets one of the following requirements:

1. Board Certified by the Institute of Noise Control Engineering of the USA with 2 years of noise control experience
2. Registered Civil engineer with 3 years of full-time noise control experience
3. Bachelor's or higher degree from an ABET accredited institution of higher education in a relevant field of engineering, environmental science, or earth science and 5 years of full-time noise control experience
4. Bachelor's or higher degree from an ABET accredited institution of higher education and 10 years of full-time noise control experience

Conduct noise monitoring by a person with at least 2 years of experience in conducting field noise measurements. Submit the qualifications of each of the individuals who will be performing the noise monitoring.

Fourteen days before starting construction activities described in the NCP, notify:

1. The Engineer
2. Entities or residents within 500 feet from the job site activity with the NCP letter delivered in person

Monitor noise:

1. The 1st time each activity described in the NCP is performed and when equipment or activities have changed from the authorized NCP
2. Each time noise complaint is received

Monitor noise on the project continuously.

Measure Noise levels with a Type 1 or Type 2 sound level meter. The sound level meter must:

1. Be calibrated and certified by the manufacturer or an independent acoustical laboratory
2. Be capable of taking A-weighted measurements and have slow response settings
3. Have a microphone fitted with a windscreen
4. Be recalibrated annually by the manufacturer or an independent NIST certified acoustical laboratory

Submit a noise monitoring report within 24 hours of completing noise monitoring for each of the activities. The report must include A-weighted noise levels, measurement location, types of noise measuring equipment including model number and identification number, time of day, temperature and wind speed.

Conduct noise monitoring to investigate noise complaints that are attributed to a particular construction operation. If the operation exceeds the sound level submit a list of authorized contingency measures from the NCP that will be implemented.

The noise level requirements apply to the equipment on the job or related to the job, including impact pile driver, trucks, transit mixers or transient equipment used on the project.

Furnish 1 Type 1 or Type 2 sound-level meter and 1 acoustic calibrator to the Department for use until contract acceptance to monitor noise.

The sound-level meter must:

1. Be calibrated and certified by the manufacturer or an independent acoustical laboratory before delivery to the Department
2. Be capable of taking A-weighted measurements and have slow response settings
3. Have a microphone fitted with a windscreen
4. Be recalibrated annually by the manufacturer or an independent acoustical laboratory

Provide noise monitoring equipment training by the authorized noise monitor to 1 Department employee.

The Department returns the equipment to you at contract acceptance.

Replace section 14-8.03 with:

14-8.03 VIBRATION MONITORING

14-8.03A General

14-8.03A(1) Summary

Section 14-8.03 includes specifications for vibration monitoring to protect facilities adjacent to the job site from vibration during _____ operations.

The work includes:

1. Furnishing, installing, and maintaining vibration monitoring instrumentation and portable vibration sensors
2. Repairing or replacing damaged or inoperable sensors immediately to ensure continuous monitoring
3. Collecting, interpreting, and reporting vibration data
4. Implementing precautionary and mitigation measures
5. Inspecting and documenting existing facilities from damage caused by vibration

Monitor vibration at the following facilities:

Facilities

Business Name	Address	Assessor's Parcel Number (APN)	Maximum peak particle velocity threshold

14-8.03A(2) Data Confidentiality

Communicate and post at all times in the field office that no personnel will disclose any instrumentation data to 3rd parties nor publish data without the Department's written consent.

14-8.03A(3) Submittals**14-8.03A(3)(a) General**

Submit qualification records for the vibration monitoring personnel.

14-8.03A(3)(b) Notifications

Notify the Engineer and facility owners 5 days before installing vibration monitoring sensors.

14-8.03A(3)(c) Vibration Sensor Product Data

Submit a copy of the instructions and maintenance manual, product data, other pertinent information; and laboratory calibration record and certification within 5 days of receipt of each portable vibration sensor at the site.

The certificate of calibration must show that the vibration sensors are calibrated and maintained as specified by the equipment manufacturer's calibration requirements and that calibrations are traceable to the U.S. National Institute of Standards and Technology (NIST).

14-8.03A(3)(d) Report of Baseline Vibration Levels

Submit baseline vibration levels before the start of construction work and include date of existing baseline condition for each vibration monitoring area. Include a summary of facility conditions and the maximum single-component and resultant peak particle velocities for one-minute intervals and additional documentation necessary for each vibration monitoring area.

Before _____ operations conduct photo and video surveys of residences and buildings, facilities, sidewalks and retaining structures within 200' of the work location under 14-8.06.

Submit a hard copy and an electronic report documenting the results at all vibration sensor locations within 14 days after the completion of the baseline vibration monitoring. Submit additional documentation necessary for each vibration monitoring area.

14-8.03A(3)(e) Vibration Monitoring and Mitigation Plan

Submit 4 copies of the vibration monitoring and mitigation plan at least 30 days before any work requiring vibration monitoring.

Revise and resubmit the plan within 7 days of receipt of comments if revisions are required.

Submit 4 copies of the vibration monitoring and mitigation plan incorporating the required changes. Allow 7 days for review of the revisions.

Minor changes or clarifications to the initial submittal may be made and attached as amendments to the plan.

The monitoring plan must include:

1. The name of the qualified vibration monitoring specialist providing the vibration monitoring services
2. Type of operation requiring monitoring
3. Description of the instruments and equipment to be used, including model number
4. Measurement locations that includes photo and caption

5. Methods for mounting the vibration sensors
6. Procedures for data collection and analysis
7. Means and methods of providing warning when the peak particle velocity equals or exceeds specified threshold
8. Name of the designated responsible person; the responsible person must have the authority to stop the work causing the vibration
9. The resumes of the vibration instrument personnel and technical support personnel

The mitigation plan must include:

1. Measures to protect the area adjacent to the job site
2. Plan of action to be implemented in the event the peak particle velocity equals or exceeds specified threshold

14-8.03A(3)(f) Vibration Data Report

Submit 1 hard copy and 1 electronic weekly report summarizing data collected, including logged data chart at each of the sensor locations. If peak particle velocity exceeds the maximum peak particle velocity threshold, submit report for review within 24 hours after each monitoring period until authorized to submit weekly. Prepare a report to tabulate the measured vibration levels of three orthogonal axes and maximum resultant and associated frequencies.

Submit summary tables indicating the date, time, magnitude, and frequency of maximum single component and resultant peak particle velocity daily.

Vibration instrumentation personnel must sign all vibration data reports. The reports must include:

1. Project identification, including county, route, post mile, and project name as shown.
2. Location of the vibration sensors (clearly label image and identify latitude and longitude location).
3. Location of vibration sources (i.e., pile driving).
4. Summary tables indicating the date, time, magnitude, and the frequency of the maximum single-component and resultant peak particle velocities for one-minute intervals for each vibration sensor. Include the relationship of the measurement to the threshold value.
5. Field data forms (construction vibration monitoring only).
6. Appendix graphs of the time history charts created during the monitoring periods.

14-8.03A(4) Quality Assurance

14-8.03A(4)(a) General

Not Used

14-8.03A(4)(b) Qualifications

Vibration monitoring personnel must have the following minimum qualifications:

1. A geologist, structural engineer, or civil engineer who is registered in the State, or a person with a Bachelor of Science or higher degree from a qualified program in engineering, physics, acoustics, or geology from an accredited university or college, and at least 5 years of experience in the installation and use of vibration monitoring instruments and data interpretation.
2. Professional experience in preparing and implementing construction vibration monitoring plans and analyzing vibration impacts.

Vibration instrumentation personnel must be onsite, supervise the installation of vibration monitoring instruments and interpretation of monitoring data.

14-8.03A(4)(c) Preconstruction Meeting

Before starting vibration monitoring installation, schedule a preconstruction meeting

Attendees must include:

1. Engineer
2. Department's vibration competent person

3. Vibration monitoring personnel
4. Vibration instrument personnel
5. Project Superintendent

The meeting agenda must include:

1. Review of the job site personnel vibration monitoring requirements
2. Emergency contacts
3. Notification plan
4. Submittals
5. Any other issues pertinent to the execution of the vibration monitoring-related work

14-8.03B Materials

Not Used

14-8.03C Construction

14-8.03C(1) General

Not Used

Comply with section 14-8.06 in documenting the existing facility's apparent deficiencies of each facility listed and adjacent to the construction activity at the job site during pre-construction and post-construction.

14-8.03C(2) Equipment

14-8.03C(2)(a) General

Not Used

14-8.03C(2)(b) Vibration Monitoring Equipment

Provide vibration sensors for monitoring the velocities of ground vibrations resulting from construction activities.

Portable vibration sensors must have the following minimum features:

1. Seismic range: 0.01 to 4 inches per second with an accuracy of ± 5 percent of the measured peak particle velocity or better at frequencies between 10 Hertz and 100 Hertz and with a resolution of 0.01 inch per second or less
2. Frequency response ± 3 dB points: 2 to 200 Hertz
3. Three channels for simultaneous time-domain monitoring of vibration velocities in digital format on 3 perpendicular axes and capable of calculating peak particle velocity resultant
4. Battery must be capable of supplying power to monitor vibrations continuously for a minimum of 24 hours
5. Capable of internal, dynamic calibration
6. Capable of transferring data from sensor memory to an external device
7. Be capable of producing time history chart recordings of readings on site within 1 hour of obtaining the readings
8. Provide computer software to perform analysis and produce reports of continuous monitoring
9. Continuous monitoring mode capable of automatic recording of single-resultant peak particle velocities and frequencies of peaks with an interval of 1 minute or less
10. Able to give warning immediately when threshold peak particle velocity is exceeded
11. Be waterproof and capable of downhole stationing

14-8.03C(2)(c) Calibration

Calibrate and maintain all equipment in working order under the equipment use specifications at the manufacturer's product maintenance schedule or certified calibration laboratory within 1 year of use onsite.

14-8.03C(3) Vibration Monitoring

Determine baseline vibration levels before start of work and vibration monitoring of the facilities identified, and when there is a break in the construction activities. Collect data using vibration sensors to document baseline vibrations at each monitoring location. Monitoring must consist of a continuous recording of the maximum single-component and resultant peak particle velocities for one-minute intervals. Perform the baseline

monitoring for a minimum of two nonconsecutive workdays, spanning the hours during which construction activities will take place.

The instrument must be in place and functioning properly before any construction activities adjacent to the identified facilities. The vibration monitoring instrument must be stationed on the side of the facility facing the work site.

Install the vibration sensors:

1. Within 3 feet of the exterior face of specified facility on the side facing construction activity or at a location designated by the qualified vibration instrumentation personnel or the Engineer. Use a minimum of 1 vibration sensor for each facility with a dimension of less than 200 feet along the side facing construction. For facilities with a dimension along the side facing construction of 200 feet or more, the spacing between the vibration sensors must be less than 200 feet or as determined by the Engineer
2. To monitor vibration at specified facilities
3. Firmly attach on the surface of concrete slabs or asphalt, or firmly set in undisturbed soil
4. Align the vibration sensors longitudinal direction of measurement parallel to the building's alignment
5. Align the vibration sensors transverse direction of measurement perpendicular to the building's alignment

Monitor and record vibration data continuously during pile driving, installation, and removal of shoring, _____ and demolition.

The equipment must provide immediate warning when peak particle velocity equals or exceeds maximum peak particle velocity threshold at any location.

When the resultant peak particle velocity on the vibration sensor equals or exceeds the maximum peak particle velocity threshold or when the facility is visually impacted, stop work immediately and notify the Engineer, followed immediately by performing survey documentation of impacted facilities. Survey documentation of impacted existing facilities is change order work.

Immediately implement vibration monitoring and mitigation plan to reduce the vibrations within 24 hours. Do not resume work unless authorized.

14-8.03D Payment

Not Used

Add to the end of section 14-9.02:

The US EPA has established the National Emission Standards for Hazardous Air Pollutants (NESHAP). Under the Health & Safety Code § 39658(b)(1), your demolition and rehabilitation activities must comply with 40 CFR 61, Subpart M (National Emission Standard for Asbestos).

The asbestos survey and sampling report for this project is included in the *Information Handout*.

You must notify the [Sacramento Metropolitan AQMD and Yolo-Solano AQMD](#) of your demolition activities even if the activities will not disturb asbestos-containing material.

You may obtain the notification form, submittal instructions, and other information from:

<https://www.ourair.org/asbestos/>

Instead of the 10 days specified at the website, submit a notification form to the [Sacramento Metropolitan AQMD and Yolo-Solano AQMD](#) at least 15 days before starting demolition or rehabilitation activities.

Submit a copy of the notification form and the necessary attachments as informational submittals before starting demolition or rehabilitation activities.

If you discover unanticipated asbestos-containing material during the demolition or rehabilitation activities, immediately stop work in that area and notify the Engineer. The Department will use other forces to remove and dispose of the material. Do not resume work in the area until authorized.

Notify the [Sacramento Metropolitan AQMD and Yolo-Solano AQMD](#) of a change to your demolition or rehabilitation activities, including a revised work plan or the discovery of unanticipated asbestos-containing materials, within 2 business days of the change or discovery.

Replace section 14-11.14 with:

14-11.14 TREATED WOOD WASTE

14-11.14A General

Section 14-11.14 applies if treated wood waste is shown on the Bid Item List.

Section 14-11.14 includes specifications for handling, storing, transporting, and disposing of treated wood waste. Manage treated wood waste under Health & Safety Code §25230 et seq.

Wood removed from [metal guardrailing](#) is treated wood waste.

14-11.14B Submittals

Within 5 business days of disposing of treated wood waste, submit as an informational submittal a copy of each completed shipping record and weight receipt.

14-11.14C Training

Provide training to personnel who handle or may come in contact with treated wood waste. Training must include:

1. Requirements of 8 CA Code of Regs
2. Procedures for identifying and segregating treated wood waste
3. Safe handling practices
4. Requirements of Health & Safety Code §25230 et seq
5. Proper disposal methods

Maintain training records for 3 years after contract acceptance.

14-11.14D Storage of Treated Wood Waste

Store treated wood waste at the jobsite until transport to the CA permitted disposal site.

Until disposal, store treated wood waste using the following methods:

1. Raise the waste on blocks above a foreseeable run-on elevation and protect it from precipitation for no more than 90 days.
2. Place the waste on a containment surface or pad protected from run-on and precipitation for no more than 180 days.
3. Place the waste in water-resistant containers designed for shipping or solid waste collection for no more than 1 year.
4. Place the waste in a storage building as defined in Health & Safety Code §25230 et seq.

Prevent unauthorized access to treated wood waste using a secure enclosure such as a locked chain-link-fenced area or a lockable shipping container located within the job site.

Resize and segregate treated wood waste at a location where debris including sawdust and chips can be contained. Collect and manage the debris as treated wood waste.

Identify treated wood waste and accumulation areas using water-resistant labels that comply with Health & Safety Code §25230 et seq. Labels must include:

1. The words *TREATED WOOD WASTE Do not burn or scavenge*
2. The words *Caltrans District* and the district number
3. The words *Construction Contract* and the contract number
4. District office address
5. Engineer's name, address, and telephone number

6. Contractor's contact name, address, and telephone number
7. Date placed in storage

14-11.14E Transport and Disposal of Treated Wood Waste

Dispose of treated wood waste within:

1. 90 days of generation if stored on blocks
2. 180 days of generation if stored on a containment surface or pad
3. 1 year of generation if stored in a water-resistant container or within 90 days after the container is full, whichever is shorter
4. 1 year of generation if stored in a storage building as defined in Health & Safety Code §25230 et seq

Before transporting treated wood waste, obtain agreement from the receiving facility that it will accept the waste. Protect shipments of the waste from loss and exposure to precipitation. For projects generating 10,000 lb or more of treated wood waste, request a generator's EPA Identification Number from the Engineer at least 5 business days before the 1st shipment. Each shipment must be accompanied by a shipping record such as a bill of lading or invoice that includes:

1. The words *Caltrans District* and the district number
2. The words *Construction Contract* and the contract number
3. District office address
4. Engineer's name, address, and telephone number
5. Contractor's name, contact person, and telephone number
6. Receiving facility's name and address
7. Description of the waste (e.g., treated wood waste with preservative type if known or unknown/mixture)
8. Project location
9. Estimated weight or volume of the shipment
10. Date accumulation begins
11. Date of transport
12. Name of transporter
13. Date of receipt by the treated wood waste facility
14. Weight of shipment measured by the receiving facility
15. Generator's US EPA Identification Number for projects generating 10,000 lb or more of treated wood waste

The shipping record must be 8-1/2 by 11 inches and a 4-part carbon or carbonless form to provide copies for the Engineer, transporter, and treated wood waste facility.

Transport treated wood waste directly to the CA permitted disposal site after leaving the jobsite. Do not mix treated wood waste from the job site with waste from any other generator.

Dispose of treated wood waste at one of the following:

1. An approved California disposal site operating under a RWQCB permit that includes acceptance of treated wood waste
2. California disposal site operating under a DTSC permit that includes acceptance of treated wood waste

Treated wood waste may be disposed as a hazardous waste at any of the following Resource Conservation and Recovery Act (RCRA) Subtitle C disposal facilities:

1. US Ecology, Beatty, Nevada
2. US Ecology, Grandview, Idaho
3. Chemical Waste Management of the Northwest, Arlington, Oregon

Replace section 14-11.16 with:**14-11.16 ASBESTOS-CONTAINING CONSTRUCTION MATERIALS IN BRIDGES****14-11.16A General**

Section 14-11.16 includes specifications for removing and managing asbestos-containing construction materials (ACCM) in bridges.

This project involves the removal and management of ACCM.

The removal and management of asbestos must comply with:

1. Health and Safety Code Div 20 Ch 6.5, Hazardous Waste Control
2. 8 CA Code of Regs § 5208
3. 8 CA Code of Regs §§ 1529 and 341.6–341.17
4. 22 CA Code of Regs Div 4.5
5. 29 CFR 1926
6. 40 CFR 61 Subpart M - National Emissions Standard for Asbestos
7. Bus & Prof Code §§ 7058.5–7058.6, 7180-7189.7, and 7028.1

Friable ACM generated as part of this project is a Department-generated hazardous waste as specified in section 14-11.07.

14-11.16B Definitions

asbestos: Any of several minerals that readily separate into long flexible fibers. Includes chrysotile, amosite, crocidolite, tremolite, anthrophyllite, actinolite, and any of these minerals that has been chemically treated, altered, or both.

asbestos-containing construction materials (ACCM): Manufactured construction material which contains more than 1/10th of 1 percent asbestos by weight under 8 CA Code of Regs § 341.6.

asbestos-containing material (ACM): Building material, including asbestos cement pipe and concrete, containing more than 1 percent asbestos by weight, area, or count under 40 CFR § 61.145.

Category I nonfriable ACM: Asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos under 40 CFR § 61.141.

Category II nonfriable ACM: Any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure under 40 CFR § 61.141.

certified asbestos consultant: Asbestos consultant certified by Cal/OSHA under 8 CA Code of Regs §§ 341.15 and 1529. A certified asbestos consultant must be registered or working for a company registered under Labor Code § 6501.5 and certified under Bus & Prof Code § 7058.6.

friable ACM: Material containing more than 1 percent asbestos, as determined by polarized light microscopy, that can be crumbled, pulverized, or reduced to powder by hand pressure when dry under 22 CCR § 66261.24.

nonfriable ACM: Material containing more than 1 percent asbestos by area with asbestos fibers that:

1. Are tightly bound into the matrix of the material
2. Should not become an airborne hazard as long as the material remains intact and undamaged and is not sawed, sanded, drilled, or otherwise abraded during removal

nonhazardous asbestos waste: ACCM with an asbestos concentration less than 1 percent or nonfriable ACM. These wastes are not hazardous wastes under 22 CA Code of Regs Div 4.5.

regulated asbestos-containing material (RACM): Under 40 CFR § 61.141, RACM is defined as any of the following:

1. Friable ACM

2. Category I nonfriable ACM that has become friable or will be or has been subjected to sanding, grinding, cutting, or abrading
3. Category II nonfriable ACM that may become, has become, or has a high probability of becoming friable

14-11.16C Site Conditions

An asbestos survey was performed for bridge no. _____.

The relevant portions of the asbestos survey report are included in the *Information Handout*. The complete report is available at:

ACCM is present and will be disturbed by work at the locations and in the types and amounts shown in the following table:

Bridge location	Asbestos location	Category of asbestos	Friable or nonfriable	Percent asbestos	Amount of asbestos

14-11.16D Submittals

14-11.16D(1) General

Not Used

14-11.16D(2) Asbestos Compliance Plan

Submit an asbestos compliance plan for preventing or minimizing workers' exposure to asbestos during demolition or renovation activities. Submit the plan at least 15 days before starting bridge demolition or renovation activities in areas containing or suspected to contain asbestos. The plan must be prepared and signed and sealed by a CIH with experience and knowledge of asbestos removal work and by the certified asbestos consultant who will direct the removal, storage, transportation, and disposal of ACM. The plan must include:

1. Identification of key personnel for the project
2. Scope of work and equipment to be used
3. Job hazard analysis for work assignments
4. Summary of risk assessment
5. Description of personal protective equipment
6. Delineation of work zones at the job site
7. Decontamination procedures
8. General safe work practices
9. Security measures
10. Emergency response plans
11. Safety training program

14-11.16D(3) Asbestos Removal Work Plan

Submit a work plan for the removal and management of asbestos 15 days before starting bridge demolition or renovation activities in areas containing or suspected to contain asbestos. The work plan must be prepared and signed and sealed by a certified asbestos consultant and include:

1. Name of the certified asbestos consultant who will direct the removal, storage, transportation, and disposal of ACM.
2. Locations at the perimeters of abatement work areas where asbestos warning signs will be installed.

3. Summary of the methods and techniques for removal, handling, packaging, labeling, storing, transporting, and disposing of waste materials.
4. Instructions for wetting asbestos materials with sprayers.
5. Description and locations of disposal bins for temporary storage of asbestos until removal from the job site.
6. Name and address of the hazardous waste transporter that will transport friable ACM. The transporter must be registered with the DTSC to transport hazardous waste under the Health and Safety Code Div 20 Ch 6.5 and 22 CA Code of Regs Div 4.5.
7. Name and address of the California disposal facility permitted for the disposal of ACM.
8. Documentation of compliance with federal, State, and local requirements for asbestos work, transport, and disposal.

14-11.16D(4) Certification of Completed Safety Training

Submit certification of completed safety training for all personnel before starting work in areas containing or suspected to contain asbestos.

14-11.16D(5) Asbestos Removal Report

Submit an asbestos removal report documenting your compliance with the asbestos removal work plan. Submit the report to the Engineer and the APCD or AQMD within 30 days after removing ACM from the job site.

14-11.16D(6) Disposal Documentation

Submit a copy of the hazardous waste manifest for each shipment of friable ACM. Submit a copy of the waste shipment record for each shipment of nonhazardous asbestos waste.

Within 5 business days of transporting hazardous and nonhazardous asbestos waste, submit documentation of proper disposal from the receiving disposal facility.

14-11.16E Health and Safety

Before starting work in areas containing or suspected to contain asbestos, provide safety training complying with 8 CA Code of Regs § 1529 to State employees who may enter the work area.

Provide training, personal protective equipment, and medical surveillance as required by the asbestos compliance plan for _____ State employees.

14-11.16F Removal and Disposal of Unanticipated Asbestos

If you discover unanticipated asbestos during demolition or rehabilitation activities, immediately stop work in that area and notify the Engineer.

The removal and disposal of ACM not identified in the asbestos survey report is change order work.

14-11.16G Removal of Asbestos

Remove asbestos under 8 CA Code of Regs § 1529 and 341 et seq. Remove friable asbestos using the wetting method. Remove and handle nonfriable asbestos such that you prevent breakage.

You are not required to remove asbestos encased in concrete or similar structural material before starting demolition. Keep the asbestos wet whenever it is exposed during demolition activities. Prevent airborne emissions from asbestos removal activities.

Mark the regulated work areas with warning signs that read, *Danger, Asbestos, Cancer and Lung Disease Hazard, Authorized Personnel Only*. The message must be legible from a distance of 20 feet by persons with 20/20 vision or vision corrected to 20/20.

14-11.16H Packaging and Temporary Storage of Asbestos-Containing Material

Package and label removed ACM under 22 CA Code of Regs § 66262.30 et seq. Place the removed ACM in minimum, 0.006-inch-thick, double-ply, plastic bags with clearly visible and legible labels affixed to the bags. The labels must read, *Danger/ Contains Asbestos Fibers/ Avoid Creating Dust/ Cancer and Lung Disease Hazard*. Wet the waste before placing it in the plastic bag to prevent asbestos fibers from becoming airborne if the bag is broken.

Do not break apart bulk waste that will not fit inside a plastic bag. Instead, wet the waste, wrap it in plastic, and seal it with packaging or duct tape until it is leak-proof. Place the wrapped and sealed ACM directly into a

covered, lockable, roll-off or drop box lined with plastic sheeting and labeled on all sides. The labels must be legible and read, *Danger/ Contains Asbestos Fibers/ Avoid Creating Dust/ Cancer and Lung Disease Hazard*.

14-11.16I Transport and Disposal of Asbestos-Containing Construction Materials

14-11.16I(1) General

Dispose of ACCM at a California disposal facility operating under a RWQCB permit to accept asbestos waste. Notify the facility at least 5 business days before the delivery of ACCM.

14-11.16I(2) Friable Asbestos-Containing Material

Transport and dispose of friable ACM as a hazardous waste. The Engineer provides the Department's EPA Identification Number for hazardous waste disposal. The Engineer signs the hazardous waste manifests. Notify the Engineer 5 business days before the manifests are to be signed.

Use a transporter for friable ACM with:

1. Current DTSC registration for transporting hazardous waste
2. US EPA Identification number
3. Proof of completion of the California Highway Patrol's Basic Inspection of Terminals Program with a satisfactory rating

The transporter's vehicles must carry a valid DTSC registration when transporting friable ACM.

14-11.16I(3) Nonhazardous Asbestos Waste

Transport nonhazardous asbestos waste to the disposal facility with a waste shipment record.

15 EXISTING FACILITIES

except for [Br. No. 22C0154, 24C0364L and 24C0006 pile caps and footings](#). Remove this concrete entirely.

[Add to the end of the 7th paragraph of section 15-1.03B.](#)

[1.5 Outside of the levee prism](#)

[1.6 Inside the levee prism provided it meets the requirements of USACE for levee backfill.](#)

Delete item 2 in the list in the 7th paragraph of section 15-1.03B.

Add to the end of section 15-1.03C:

At least 2 business days before hauling the material to the salvaged material stockpile location, notify the Engineer.

The stockpile locations are as shown in the following table:

Material	Location
<u>City of Sacramento Materials</u>	<u>City Corporation Yard, 5730 24th Street, Building 11, Sacramento, California or Corporate Center North, 918 Del Paso Road, Sacramento, CA</u>
<u>City of West Sacramento Materials</u>	<u>City of West Sacramento Corporation Yard at: 1951 South River Road, West Sacramento, CA 95691</u>

17 GENERAL

17-2.03E Tree Removal

Under this item, the contractor shall remove a standing tree, and pull, grind, or excavate the root ball. All loose material and disturbed soil from the root area shall be removed, and the resulting cavity filled with ¾" crushed rock up to local subgrade and compacted to 95%.

Contractor shall notify the Urban Forestry Department and the Engineer at least fifteen (15) working days prior to removing any tree.

- Heritage trees: with a circumference greater than 75" (CBH)
- Oak trees: with a circumference greater than 50" (CBH)
- Street trees: trees that are within 12.5' of the curb

Payment for tree removal shall be made per each remove tree and shall include full compensation for furnishing all labor, material, tools, equipment, incidentals and for doing all work involved in remove tree as shown on the plans, as specified in the City Standard Specifications, the City of West Sacramento's Tree Ordinance, these Special Provisions and as directed by the Engineer.

19 EARTHWORK

Replace section 19-2 with:
19-2 ROADWAY EXCAVATION

19-2.01 GENERAL**19-2.01A Summary**

Roadway excavation shall conform to Section 14 of the City Standard Specifications and these Special Provisions.

19-2.02 MATERIALS

Excavation shall include saw cutting and removal of all asphalt concrete (AC), aggregate base (AB), native material, tree roots and soil to allow construction of improvements to the lines and grades shown on the Plans. This item shall include grading behind the proposed sidewalk and driveways necessary to match the existing grades and improvements.

This work shall include excavation and grading necessary to construct the proposed street section, median, driveways, walkways and shall include finish grading to match the back of sidewalk to surrounding grade per the construction plans. This work shall include shaping and trimming of slopes, and the placement and compaction of excavated earth material to the lines and grades shown on the Plans.

All existing asphalt pavements to be removed shall be full depth saw-cut at the limits of removal as shown on the Plans and in accordance with Section 13 of the Standard Specifications.

Excess excavated material shall become the property of the Contractor and shall be deposited in a location and manner satisfactory to the Engineer. When any material is to be disposed of outside the right-of-way, the Contractor shall obtain written permission from the owner upon whose property the disposal is to be made before any material is deposited thereon.

19-2.03 CONSTRUCTION

The Contractor shall prepare a written, project-specific Excavation and Transportation Plan establishing the procedures the Contractor will use to comply with requirements for excavating, stockpiling, transporting, and placing (or disposing) of soil/debris material. The plan shall conform to the regulations of the DTSC and Cal-OSHA. The sampling and analysis portions of the Excavation and Transportation Plan shall be in general conformance with USEPA, SW 846, "Test Methods for Evaluating Solid Waste". The plan shall contain, but not be limited to the following elements:

- Excavation schedule
- Temporary locations of stockpiled material
- Sampling and analysis plans for stockpiles:
- Location and number of samples
- Analytical laboratory
- Dust control measures
- Air monitoring
- Transportation equipment and routes
- Method for preventing spills and tracking material onto public roads
- Truck waiting and staging areas
- Site for disposal of waste
- Spill Contingency Plan for material containing contaminants of concern

Excavation, transportation, and handling of soil/debris containing contaminants of concern shall result in no visible dust migration. The Contractor shall have a water truck or tank on the job site at all times while performing earthwork operations.

Soil/debris stockpiles shall not be placed where affected by surface run-on or run-off. Stockpiles shall be covered with plastic sheeting, 13 mils minimum thickness. Stockpiles shall not be placed in environmentally sensitive areas. Stockpiled material shall not enter storm drains, inlets, or waters of the State. The Contractor shall maintain the stockpile covers so the entire pile is covered at all times except during soil placement, sampling, and soil removal. Covers shall remain in place until all soil is removed from the site.

For Non-Hazardous waste, haulers should be provided with non-hazardous manifests for each truckload transported to a landfill. In addition to the manifest, the hauler should have a description of the waste (soil), where it came from, the expected concentrations, etc.

Prior to traveling on public roads, loose and extraneous material shall be removed from surfaces outside the cargo areas of the transporting vehicles and the cargo shall be covered with tarpaulins or other cover, as outlined in the approved Excavation and Transportation Plan. The Contractor shall be responsible for costs due to spillage of soil/debris during transport.

Existing Facilities

The Contractor shall exercise extreme care to avoid damaging the curb and gutter lips, slope paved embankments, abutments, concrete gutter swales, sidewalks, and planting areas during excavation operations. Gutter lips damaged by the Contractor which are spalled in excess of one inch (1") deep by five inches (5") long will be repaired at the Engineer's direction. The cost of repairs to damaged curb and gutter shall be considered as included in this item, and no separate payment shall be made therefore.

Excavation near high-pressure gas facilities shown on the plans shall be performed with hand equipment.

19-2.04 PAYMENT

Payment for roadway excavation shall be made per cubic yard of material excavated and shall include full compensation for furnishing all labor, material, tools, equipment, incidentals and for doing all work involved in roadway excavation as shown on the plans, as specified in the City Standard Specifications, these Special Provisions and as directed by the Engineer.

Add to the end of section 19-3.01A:

Structure backfill includes constructing the geocomposite drain system. The systems must comply with section 68-7.

Add between the 8th and 9th paragraphs of section 19-3.03E(1):

For bridge no. 22C0193, Pier 2 , Pier 3 , Pier 4 and Pier 5 are in a waterway or water channel.

Add to section 19-3.04:

Except at locations where seal course concrete is shown, structure excavation for footings at locations not shown as structure excavation (Type A) and where ground or surface water is encountered is paid for as structure excavation (bridge).

Pervious backfill material placed within the limits of payment for retaining walls is paid for as structure backfill (retaining wall).

Add to the end of section 19-7.02C:

Import volumes are based on theoretical values and do not include shrinkage.

This work shall include grading and compaction necessary to construct the proposed street section and shall include finish grading to match the back of sidewalk to surrounding grade using slopes per the construction plans. This work shall include shaping and trimming of slopes, and the placement and compaction of excavated earth material to the lines and grades shown on the Plans.

The on-site soil may be used as fill provided it is free of debris and visible concentrations of vegetation, and has a maximum particle size of 1 inch.

Imported material placed within 2.5 ft of the finish pavement subgrade should meet the following requirements:

1. Free of organic or other deleterious materials.
2. Minimum R-value of 20 to meet the pavement design criteria.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

20 LANDSCAPE

Replace section 20-1.01D(3) with:

20-1.01D(3) Soil Testing

Provide an agronomic soil test from a laboratory that uses methods of soil analysis approved by the American Society of Agronomy and the Soil Science Society of America.

Collect soil samples from at least 4 different locations at a depth from 8 to 14 inches from the surface.

Use sample locations that best represent areas that will be used for planting and seeding work. Sample locations must be authorized. Collect testing samples after the finished grade is achieved.

Test Results must include the following:

Test Element	Method
pH	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 16 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 21a
Saturation Extract	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 14 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 2
Sodium Adsorption Ratio	Methods of Soil Analysis, Part 3 chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 14 or Inductively Coupled Argon Plasma Optical Emissions, EPA Method 6010B
Water Infiltration Rate	USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 34B
Base Saturation	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 40 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 18, 19 and 20
Exchangeable Ammonium cation	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 38
Cation Exchange Capacity	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 40 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 18, 19 and 20
Electrical Conductivity	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 14 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 2
Soil Texture	Methods of Soil analysis, Part 1, Physical and Mineralogical Methods, Soil Science Society of America, Inc., 1986, Chapter 15
Organic Content	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 37
Boron	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 38 or Inductively Coupled Argon Plasma Optical Emissions, EPA Method 6010B
Calcium	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 40 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 18, 19 and 20 or Inductively Coupled Argon Plasma Optical Emissions, EPA Method 6010B
Chloride	Methods of Soil Analysis, Part 3 chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 14 or USDA Agricultural handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, Method 2 or Inductively Coupled Argon Plasma Optical Emissions, EPA Method 6010B
Copper	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 26, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Iron	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 23, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Magnesium	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 20, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Calcium/Magnesium Carbonate	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 34

Manganese	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 24, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Molybdenum	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 27, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Nitrate	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 31, Ion Selective Electrodes (ISE), Method
Phosphorus	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 32, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Potassium	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 19, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Sodium	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 19, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Sulfate/Sulfur	Communication Soil Science Plant Analysis, Chapter 33, 2002 Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method, Optimization of a Method for soil sulfur extraction,
Zinc	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapter 26, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Aluminum	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapters 25, 27, 28, 29, 30, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method
Selenium	Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc., 1996 Chapters 25, 27, 28, 29, 30, Ammonium Bicarbonate-Diethylenetriaminepentaacetic Acid (AB-DTPA) Method

Laboratory interpretation data must cite low, medium, and high nutrient concentrations, nutritional deficiencies, excesses, and potential toxicities. Test results must include amendment recommendations for new and existing planting and seeding.

Submit test results and any recommended design modifications as a result of the test 15 days before any planting, seeding, or soil amendments activities.

Add to the list in the 1st paragraph of section 20-1.03C(1):

3. Removing noxious and invasive plants

Replace the 1st paragraph of section 20-1.03C(2) with:

Add to section 20-1.03C(3):

Control weeds within the highway including medians and surfaced areas such as new and existing pavement, curbs, and sidewalks.

In groundcover areas and within the area extending beyond the outer limits of the groundcover to the adjacent edges of shoulders, dikes, curbs, sidewalks, walls, existing planting, and fences, control weeds with pesticides or by hand pulling. Where groundcover areas are 12 feet or more from the adjacent edges of shoulders, dikes, curbs, sidewalks, walls, and fences, control weeds within the groundcover areas and 6 feet beyond the outer limits of the groundcover areas.

In mulched areas and within the area extending beyond the outer limits of the mulched areas to the adjacent edges of shoulders, dikes, curbs, sidewalks, walls, existing planting, and fences, control weeds with pesticides or by hand pulling. Where mulched areas are 12 feet or more from the adjacent edges of shoulders, dikes, curbs, sidewalks, walls, and fences, control weeds within the mulched areas and 6 feet beyond the outer limits of the mulched areas.

Within 2 feet of the edges of paved shoulders, dikes, curbs, and sidewalks, control weeds with pesticides or by hand pulling.

In areas where plants are to be planted in groups or rows 15 feet or less apart, control weeds within the planting area and the area extending 6 feet beyond the outer limits of the groups or rows of plants with pesticides or by hand pulling. Hand pull weeds within and on the plant basin walls, spot treat with pesticides outside of the plant basin.

Where the plants are to be planted more than 15 feet apart and are located outside of groundcover areas, control weeds with pesticides or by hand pulling within an area 6 feet in diameter centered at each plant location. Hand pull weeds within and on the plant basin walls, spot treat with pesticides outside of the plant basin.

Control weeds under guard rails, from within asphalt concrete surfacing, concrete surfacing, rock blankets, rock mulch, gravel mulch or decomposed granite areas, and unpaved gore areas between the edge of pavement and planting areas with pesticides or by hand pulling.

For information on photographic identification of weed species go to the Department of Food and Agriculture or the California Invasive Plant Council websites.

Replace the 2nd paragraph of section 20-1.03C(4) with:

Dispose of mowed material during roadside clearing. Dispose of noxious and invasive plants within 3 days of removal. Dispose of seed pods and heads the same day as removed. Prevent seed dispersal during transportation to the disposal site.

Add to section 20-2.01(B):

20-2.01B(10) Irrigation System - West Sacramento

This item shall consist of furnishing and installing Irrigation System as shown on the Drawings in conformance to applicable paragraphs of Section 17 (Irrigation System) of City of West Sacramento Standard Specification and Plans and these Special Provisions.

Included in the work shall be furnishing and installing new electrical connection, irrigation controller, enclosures, irrigation wire and conduit, water meter, reduced pressure backflow preventer assembly, master valve, flow sensor, supply line, mainline, lateral line, sleeving, gate valve, quick coupling valve, remote control valve assembly, tree bubbler, shrub bubbler, decoder, flow sensor cable, enclosure, receiver, surge protector, recycled water use signage, and all appurtenances shown on the Plans and called for in these Special Provisions.

Materials: The equipment shall be of the same type and size as indicated on the Drawings. If not specifically shown, provide equipment in accordance with the applicable Standard Specifications. Product cutsheet shall be submitted for review and approval prior to ordering. Refer to bid item "Electrical Service Connection" for associated electrical components and power connection.

20-2.01B(11) Irrigation System - Sacramento

This item shall consist of furnishing and installing Irrigation System as shown on the Drawings in conformance to applicable paragraphs of Sections 36 (Irrigation System) of the City of Sacramento Standard Specifications and Plans and these Special Provisions.

Included in the work shall be furnishing and installing electrical connection - extending from existing system, irrigation controller, enclosures, irrigation wire and conduit, water meter, backflow preventer assembly, master valve, flow sensor, supply line, mainline, lateral line, sleeve, gate valve, quick coupling valve, remote control valve assembly, drip remote control valve, tree bubbler, subsurface inline drip system, flow sensor cable, enclosure, receiver, surge protector, recycled water use signage, and all appurtenances shown on the Plans and called for in these Special Provision.

Materials: The equipment shall be of the same type and size as indicated on the Drawings. If not specifically shown, provide equipment in accordance with the applicable Standard Specifications. Product cutsheet shall be submitted for review and approval prior to ordering. Refer to bid item "Electrical Service Connection" for associated electrical components and power connection.

Replace section 20-2.01D with:

20-2.01D(1) Irrigation System - West Sacramento

Payment of Irrigation System - West Sacramento shall be at the unit price per lump sum and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals; and for doing all the work involved in installing and testing the irrigation system, complete in place, as shown on the plans, and specified in these specifications and any special provisions, and as directed by the City Engineer, including any structure excavation, structure backfill and water involved.

Contractor shall provide a schedule of values for the following items included in this lump sum price bid:

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>
<u>NEW ELECTRICAL CONNECTION</u>	<u>EA</u>	
<u>IRRIGATION CONTROLLER WITH PEDESTAL ENCLOSURE</u>	<u>EA</u>	
<u>WATER METER, 1"</u>	<u>EA</u>	
<u>REDUCED PRESSURE BACKFLOW PREVENTER ASSEMBLY WITH ENCLOSURE, 1"</u>	<u>EA</u>	
<u>MASTER VALVE, 1-1/2"</u>	<u>EA</u>	
<u>FLOW SENSOR, 1-1/2"</u>	<u>EA</u>	
<u>IRRIGATION WIRE AND CONDUIT</u>	<u>LS</u>	
<u>IRRIGATION SUPPLY LINE (POLYETHYLENE)</u>	<u>LF</u>	
<u>MAINLINE, 2" DIA.</u>	<u>LF</u>	
<u>LATERAL LINE</u>	<u>LF</u>	
<u>SLEEVE</u>	<u>LF</u>	
<u>GATE VALVE, 2"</u>	<u>EA</u>	
<u>QUICK COUPLING VALVE, 1"</u>	<u>EA</u>	
<u>REMOTE CONTROL VALVE ASSEMBLY</u>	<u>EA</u>	
<u>TREE BUBBLER (2 PER TREE)</u>	<u>EA</u>	
<u>SHRUB BUBBLER</u>	<u>EA</u>	
<u>RECYCLED WATER USE SIGNAGE</u>	<u>EA</u>	

20-2.01D(2) Irrigation System - Sacramento

Payment shall be at the unit price per lump sum and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals; and for doing all the work involved in installing and testing the irrigation system, complete in place, as shown on the plans, and specified in these specifications and any special provisions, and as directed by the City Engineer, including any structure excavation, structure backfill and water involved.

Contractor shall provide a schedule of values for the following items included in this lump sum price bid:

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>
<u>ELECTRICAL CONNECTION - EXTENDING FROM EXISTING SYSTEM</u>	<u>EA</u>	
<u>IRRIGATION CONTROLLER WITH PEDESTAL ENCLOSURE</u>	<u>EA</u>	
<u>WATER METER, 1"</u>	<u>EA</u>	
<u>REDUCED PRESSURE BACKFLOW PREVENTER ASSEMBLY WITH ENCLOSURE, 1"</u>	<u>EA</u>	
<u>MASTER VALVE, 1-1/2"</u>	<u>EA</u>	
<u>FLOW SENSOR, 1-1/2"</u>	<u>EA</u>	
<u>IRRIGATION WIRE AND CONDUIT</u>	<u>LS</u>	
<u>IRRIGATION SUPPLY LINE (COPPER K)</u>	<u>LF</u>	
<u>MAINLINE, 2" DIA.</u>	<u>LF</u>	
<u>LATERAL LINE</u>	<u>LF</u>	
<u>SLEEVE</u>	<u>LF</u>	
<u>GATE VALVE</u>	<u>EA</u>	
<u>QUICK COUPLING VALVE, 1"</u>	<u>EA</u>	
<u>REMOTE CONTROL VALVE ASSEMBLY</u>	<u>EA</u>	
<u>DRIP REMOTE CONTROL VALVE ASSEMBLY</u>	<u>EA</u>	
<u>TREE BUBBLER (2 PER TREE)</u>	<u>EA</u>	
<u>SUBSURFACE INLINE DRIP IRRIGATION</u>	<u>SF</u>	

Add to section 20-3.01B(2):**20-3.01B(2)(d) Trees (24" Box)**

This item shall consist of furnishing and installing Trees (24" Box) as shown on the Drawings in conformance to the provisions of Sections 35-7 (Planting Trees) of the City of Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of City of West Sacramento Standard Specification and Plans.

20-3.01B(2)(e) Trees (15 Gal)

This item shall consist of furnishing and installing Trees (15 Gal) as shown on the Drawings in conformance to the provisions of Sections 35-7 (Planting Trees) of the City of Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of City of West Sacramento Standard Specification and Plans.

20-3.01B(2)(f) Shrub and Groundcover (1 Gal)

This item shall consist of furnishing and installing Shrubs and Groundcover (1 Gal) as shown on the Drawings in conformance to the provisions of Sections 35-8 (Planting Shrub and Groundcover areas) of the City of

Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of City of West Sacramento Standard Specification and Plans.

Replace section 20-3.01B(3)(b) with:

20-3.01B(3)(b) Soil Amendment

This item shall consist of applying soil amendment to all the planting areas with permanent irrigation system as shown on the Drawings in conformance with the applicable paragraphs of Sections 35 of the Standard Specifications, Section 16 (Landscaping) of West Sacramento Standard Specifications and these Special Provisions.

For bidding purposes, assume the following per 1,000 square feet:

1. 4 cubic yards of compost, incorporated into the top 6 inches of soil
2. 10 lbs of 16-6-8 slow-release fertilizer
3. 1 lb of granular sulfur fertilizer

Final compost and fertilizer types and application rates shall be confirmed based on the soil test results in accordance with MWEL requirements

Add to section 20-3.01B:

20-3.01B(12) Root Barrier

This item shall consist of furnishing and installing Root Barrier as shown on the Drawings in conformance with the applicable paragraphs of Sections 16 of (Landscaping) of West Sacramento Standard Specifications and these Special Provisions. Product materials shall be as indicated on the Plans and Install per manufacturer's specifications.

Replace section 20-3.01D with:

20-3.01D Payment

20-3.01D(1) Trees (24" Box)

Payment shall be at the unit price bid per each for all trees (24" box) and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in tree planting, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

20-3.01D(2) Trees (15 Gal)

Payment shall be at the unit price bid per each for all trees (15 Gal) and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in tree planting, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

20-3.01D(3) Shrub and Groundcover (1 Gal)

Payment shall be at the unit price bid per each for all shrubs and ground cover (1 Gal) and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in landscape shrub planting with proper fertilizer tablets, weed control, and fine grading, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

20-3.01D(4) Soil Amendment

Payment shall be at the unit price bid per square foot and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in soil amendment, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

20-3.01D(5) Root Barrier

Payment shall be at the unit price bid per linear foot and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in root barrier, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

Replace section 20-4.01B with:

20-4.01B Definitions

Landscape Establishment and Maintenance, 180 Days: This item shall consist of Landscape Maintenance for the landscape planted areas installed in this Contract as shown on the Drawings in conformance with the applicable paragraphs of Sections 35-13 to 35-18 of the City of Sacramento Standard Specifications and Plans and Section 16.08 (Maintenance Period) of West Sacramento Standard Specifications and these Special Provisions.

The Landscape Maintenance Period shall be six months (180 calendar days) and shall begin on the date of the Start of Maintenance Period. Plant Establishment and Landscape Maintenance shall continue until final acceptance of the work.

At the time of final acceptance of the work, all planted areas shall be weed free, as determined by the Engineer. At the end of the maintenance period, a minimum of 90% plant survival is required.

Replace section 20-4.04 with:

20-4.04 PAYMENT

Payment for landscape establishment and maintenance, 180 days shall be at the unit price bid per lump sum and shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals and for doing all work involved in the maintenance as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

Replace section 20-5.02B(6) with:

20-5.02B(6) Metal Edging

This item shall consist of furnishing and installing Metal Edging as shown on the Drawings in conformance with the provisions of Section 20-5 of the Caltrans Standard Specifications, and as shown on the Plans or as directed by the Engineer.

Metal Edging shall be commercial grade steel edging, minimum 1/4" thick by 6" deep, Stainless Steel color and finish, with galvanized steel stakes. Available at Colmet, (972) 494-3900 or approved equal. All edging shall be installed flush with adjacent paving or finish grades, and secured in place per manufacturer recommendations. Splices shall be tightly butted and staked at both ends to prevent separation.

Add to section 20-5.02D:

Payment for metal edging shall be at the unit price bid per linear foot and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in furnishing and installing metal edging complete in place, as shown on the Plans, and as specified in these Special Provisions, and as directed by the Engineer.

Replace Reserved in section 20-5.03B(1)(b) with:

Grouted River Rock Surface: Where the Plans or Details call for "Grouted River Rock Surface" or similar terminology, the work shall be considered Rock Blanket and shall comply with all requirements of Section 20-5.03B Rock Blanket, including rock gradation, bedding preparation, placement, grouting, finish appearance, and cleanup.

Add to the end of section 20-5.03B(1)(c):

Submit technical data, manufacturer's specifications, and a work plan for mixing, delivery, placement, finishing, and curing of concrete with integral color.

Replace section 20-5.03B(1)(d) with:**20-5.03B(1)(d) Quality Assurance****20-5.03B(1)(d)(i) General**

Not Used

20-5.03B(1)(d)(ii) Quality Control

Construct test panels for rock blanket work at an authorized location. Test panels must demonstrate rock placement, removal of concrete and mortar residue from rock surfaces, and when required, colored concrete. Test panels must comply with section 51-1.01D(2)(c), except test panel size must be at least 4 by 4 feet by 6 inches deep.

Rock, cementitious materials and aggregates from the same sources used in the authorized test panel must be used for the completed rock blanket work.

20-5.03B(1)(d)(iii) Department Acceptance

Test panels must be authorized at least 5 business days before starting work.

The Department accepts rock blanket work based on a visual comparison with the authorized test panel.

Remove test panels when directed by the Engineer and restore location to original condition.

Add to the end of section 20-5.03B(2)(a):

Do not use preemergent.

Add to the end of section 20-5.03B(2)(b):**Replace the table in the 1st paragraph of section 20-5.03B(2)(c) with:****Gradation Requirements**

Screen size (inches)	Percentage passing
<u>6</u>	<u>100</u>
<u>4</u>	<u>50-85</u>
<u>2</u>	<u>0-50</u>

Add to the end of section 20-5.03B(2)(c):

Local river rock color must be shades of warm beige, grey, and brown. Suggested source: Decorative Cobblestone by Greenwaste Florin Perkins Landscape Materials, (916) 303-9900.

Add to the end of section 20-5.03B(2)(d):

Mortar must be colored to match the concrete color.

Add to section 20-5.03B(2):**20-5.03B(2)(e) Reinforcement****Add to the end of section 20-5.03B(3):**

Where shown, saw cut the edge of asphalt or concrete surface to the full depth of rock blanket. Saw cut edge must be smooth.

Add to section 20-5.03B(4):

Payment for grouted river rock surface shall be at per square foot price bid and shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved with installing the grouted river rock surface as shown on the Plans, as specified in these Special Provisions and as directed by the Engineer.

Replace item 1 in the list in the paragraph of section 20-5.03D(2)(a) with:

1. Uniform Gray color

Add to section 20-5.03D(2):**20-5.03D(2) Materials****20-5.02D(2)(c) Decomposed Granite (Stabilized)**

This item shall consist of furnishing and installing Decomposed Granite (Stabilized) surface as shown on the Drawings in conformance to the Plans and these Special Provisions.

Decomposed granite shall be a natural, weathered granite aggregate material, uniform gray color, and shall be installed with a stabilized binder approved for vehicular use. The finished surface shall be firm, stable, and permeable, compacted to a uniform thickness and even finish as shown on the Plans.

Stabilizer shall be pre-blended per manufacturer recommendations and thoroughly mixed prior to installation. The final surface shall be fine-graded, rolled, and moistened to activate the stabilizer and achieve a consistent, compacted surface free from loose material or rutting.

Replace section 20-5.03D(4) with:**20-5.02D(4) Payment**

Payment shall be at per square foot price bid and shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved with installing the stabilized decomposed granite complete in place, including stabilizer, subgrade preparation and compaction, as shown on the Plans, as specified in these Special Provisions and as directed by the Engineer.

Replace section 20-5.04B(7) with:**20-5.04B(7) Mulch (3" Deep)**

This item shall consist of furnishing and installing Mulch as shown on the Drawings in conformance with the applicable paragraphs of Sections 35-8 (Planting Shrub and Groundcover areas) of the City of Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of West Sacramento Standard Specifications and these Special Provisions.

All mulch shall comply with the requirements of California Senate Bill (SB) 1383, which mandates the use of recovered organic waste products in landscape applications. Mulch shall be clean, free of refuse, weeds, or foreign material, and shall have a natural, uniform appearance suitable for landscape use.

Mulch shall be installed to a uniform 3" depth as shown on the drawings.

Add to section 20-5.04D:

Payment for mulch (3" deep) shall be at the unit price bid per square foot for bark mulch and shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals and for doing all work involved in installing bark mulch as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

Replace section 20-5.05A with:**20-5.05 SITE FURNISHINGS****20-5.05A General**

Not Used

20-5.05B Materials**20-5.05B(1) Interpretive Display Board**

This item shall consist of furnishing and installing Interpretive Display Board as shown on the Drawings in conformance to the provisions of manufacturer Specifications. Interpretive Display Board must comply with the manufacturer's instructions for use and job site conditions.

The Interpretive Display Board in the plaza shall be 24x36", high pressure laminate panel (embedded phenolic resin), on a standard angle-mount frameless and single post. Sign panels and pedestal is available from VackerSign (vackersign.com) or approved equal.

Posts shall be surface mounted. Posts, frames, and base plates shall be metal, and powder coated standard black.

Contractor shall coordinate with the City to obtain high quality images for printing.

Assemble and install boards per manufacturer's instructions. Ensure that drilled anchorage holes on concrete pavement do not damage bar reinforcement.

Prior to ordering or fabrication, submit shop drawings showing product information and dimensions of the boards and frames to be installed. Submit a final check-print of the board graphics to the City.

20-5.05B(2) Removable Bollard

This item shall consist of furnishing and installing Removeable Bollard as shown on the Drawings in conformance to the provisions of manufacturer Specifications. Removable bollard must comply with the manufacturer's instructions for use and job site conditions.

Removable Bollard shall be 'Stop' bollard by Landscape Forms, or approved equal. The bollard shall be 34" high, with a galvanized socket embedded in concrete. Post is standard matte black and sleeve can be powder coated in silver metallic color.

Contractor shall provide two (2) sets of keys to the City.

Warranty: Manufacturer shall warrant the products to be free from defects in material and/or workmanship for a period of three years from date of invoice. Manufacturer shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized service representative. The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

20-5.05B(3) Bench

This item shall consist of furnishing and installing Bench as shown on the Drawings in conformance to the manufacturer Specifications.

Bench shall be modeled in Metro40 by Landscape Forms, (269) 381-0396 or approved equal. The bench shall be 80" wide, with back and arm rest on both sides and the center. Color and finish to be silver metallic powder-coating.

Warranty: Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice. Manufacturer shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.

20-5.05C Construction

20-5.05C(1) General

The contractor shall install all materials in accordance with Plans, Details, and Specifications.

20-5.05C(2) Execution

Examination: Verify that conditions are satisfactory for installation of each item of site elements. If unsatisfactory conditions exist, do not begin installation until such conditions have been corrected.

Layout: Prior to commencing installation, Contractor shall stake layout and request a review by the Engineer or City Inspector to determine adjustments on site from locations shown on drawings.

Installation: All site accessories shall be installed as shown on plans and per manufacturer's specifications.

Guarantee: At completion of project, Contractor shall provide City with written guarantee from each manufacturer identifying the nature of warranty for each product component.

20-5.05D Payment

Payment for interpretive display board shall be unit price bid for each interpretative Display Board and shall include full compensation for furnishing all labor, anchorage devices, delivery, printing, signage materials, tools, equipment and incidentals, and for doing all work involved with installing interpretative display board as shown on the plans, as specified in these Special Provisions and as directed by the Engineer.

Payment for removable bollard shall be unit price bid for each removeable bollard and shall include full compensation for all labor, materials, tools, equipment and incidentals and for doing all work involved in installing removeable bollards, complete in place as shown on the plans, as specified in these Special Provisions and as directed by the Engineer.

Payment for bench shall be unit price bid for each bench and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing benches, complete in place, including accessories, footings, and mounting, as shown on the plans, as specified in the State Standard Specifications, these Special Provisions and as directed by the Engineer.

Replace section 20-5.07 with:

20-5.07 ORNAMENTAL METAL FENCE AND GATE

20-5.07A General

Not Used

20-5.07B Materials

20-5.07B(1) Ornamental Metal Swing Gate - At Operator House

The Contractor shall install Ornamental Metal Swing Gate - At Operator House and its footing in accordance with the Plans and Manufacturer Specifications. Ornamental metal swing gate must comply with the fabricator's instructions for use and job site conditions. Shop drawings are required for review and approval prior to ordering.

All fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

Contractor shall provide two (2) sets of keys to the City.

20-5.07B(2) Ornamental Metal Swing Gate - At Water Tower

The Contractor shall install Ornamental Metal Swing Gate - At Water Tower and its footing in accordance with the Plans and Manufacturer Specifications. Ornamental metal swing gate must comply with the fabricator's instructions for use and job site conditions. Shop drawings are required for review and approval prior to ordering.

All fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

Contractor shall provide two (2) sets of keys to the City.

20-5.07B(3) Ornamental Metal Fence

The Contractor shall furnish and install the ornamental metal fence and associated concrete footings in accordance with the Contract Plans and the Manufacturer's specifications. Installation shall comply with the fabricator's instructions and be appropriate to the job site conditions.

All fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

Shop drawings shall be submitted for review and approval prior to fabrication or ordering of materials. Staking of the fence alignment and locations is required and shall be approved by the Engineer prior to installation.

20-5.07B(4) Security Metal Fence

The Contractor shall furnish and install the Security metal fence and associated concrete footings in accordance with the Contract Plans and the Manufacturer's specifications. Installation shall comply with the fabricator's instructions and be appropriate to the job site conditions.

All fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

Shop drawings shall be submitted for review and approval prior to fabrication or ordering of materials. Staking of the fence alignment and locations is required and shall be approved by the Engineer prior to installation.

20-5.07B(5) Ornamental Metal Railing

The Contractor shall furnish and install ornamental metal railing in accordance with the Contract Plans and the Manufacturer's specifications. All materials and installation shall comply with the fabricator's instructions and be suitable for the job site conditions.

All railing components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

Shop drawings shall be submitted for review and approval prior to fabrication or ordering of materials. Staking of the railing alignment and installation locations shall be completed and approved by the Engineer prior to installation.

20-5.07C Construction**20-5.07C(1) General**

Not Used

20-5.07C(2) Fabrication

Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets. The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Industrial weight fences under ASTM F2408.

20-5.07C(3) Preparation

All new installation shall be laid out by the contractor in accordance with the construction plans.

20-5.07C(4) Fence Installation

For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36". Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color.

20-5.07C(5) Gate Installation

Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

20-5.07C(6) Cleaning

The contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

20-5.07D Payment

Payment for ornamental metal swing gate at operator house shall be at the unit price bid per lump sum and shall include full compensation for all labor, materials, footing, hardware, tools, equipment and incidentals and for doing all work involved in installing fences, gates, hinge, latch, lock, and footing as shown on the plans, as specified in the State Standard Specifications, these Special Provisions and as directed by the Engineer.

Payment for ornamental metal swing gate at water tower shall be at the unit price bid per lump sum and shall include full compensation for all labor, materials, footing, hardware, tools, equipment and incidentals and for doing all work involved in installing fences, gates, hinge, latch, lock, and footing as shown on the plans, as specified in the State Standard Specifications, these Special Provisions and as directed by the Engineer.

Payment for ornamental metal fence shall be per linear foot for ornamental metal fence shall include full compensation for all labor, materials, tools, equipment and incidentals and for doing all work involved in installing fences, hardware, and footings as shown on the plans, as specified in the State Standard Specifications, these Special Provisions and as directed by the Engineer.

Payment for security fence shall be per linear foot for security metal fence shall include full compensation for all labor, materials, tools, equipment and incidentals and for doing all work involved in installing fences, hardware, and footings as shown on the plans, as specified in the State Standard Specifications, these Special Provisions and as directed by the Engineer.

Payment for ornamental metal railing shall be per linear foot price bid and shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved with installing ornamental metal railing hardware, and the footings as shown on the plans, as specified in these Special Provisions and as directed by the Engineer.

Replace section 20-5.08 with:**20-5.08 RELOCATE EXISTING MONUMENT****20-5.08A General**

Relocate Existing Monument consists of removing, protecting, transporting, and reinstalling the existing monument at the location shown on the plans or as directed by the Engineer. This work includes removing the existing footing, furnishing and installing a new footing, and reconnecting all existing lighting and any attached signage or plaques. Perform the work in accordance with Section 15, "Existing Facilities," of the Caltrans Standard Specifications, these Special Provisions, and the plans.

Protect the monument and all associated components from damage throughout the Work. Any damage resulting from Contractor operations shall be repaired or replaced at no additional cost to the Contract.

20-5.08B Materials**20-5.08B(1) Monument, Signage, and Uplighting**

Reuse the existing monument structure, attached signage, plaques, and uplights.

20-5.08B(2) Footing

Furnish concrete, reinforcement, and anchorage hardware necessary to install the monument at the new location. The new footing shall:

1. Match the size, depth, and structural capacity of the existing footing to the extent practicable, based on field verification.
2. Be modified as required to suit actual field conditions, including soil conditions and monument dimensions.

20-5.08B(3) Electrical Components

Reuse existing uplights and wiring where feasible. Replace damaged or unusable components in kind. Conduits, boxes, connectors, and wiring shall meet the applicable requirements of Section 86.

20-5.08C Construction**20-5.08C(1) General**

Not Used

20-5.08C(1) Field Verification and Protection

Inform the City of West Sacramento at least 10 business days prior to field verification. Verify existing monument dimensions, anchorage, and footing configuration prior to removal. Protect monument surfaces and ornamentation from chipping, scratching, or cracking. Submit a proposed footing detail for approval if field conditions differ from the existing footing or if the original footing dimensions cannot be replicated.

20-5.08C(2) Salvage and Removal

Carefully salvage the existing monument and uplights and protect them from damage during removal, handling, transport, and storage. Existing footing shall be removed to allow installation of new improvements.

However, if approved by the Engineer, the lower portion of the existing footing may be left in place, provided that the Contractor:

1. Removes the upper 12 inches of the footing below finished grade, and
2. Backfills and compacts the resulting excavation with suitable material per Plans.

Any remaining footing must not interfere with new work or future utilities.

20-5.08C(3) New Footing

Excavate and construct new reinforced concrete footing as verified in the field. Install anchorage to secure monument in an upright, plumb, and stable position.

20-5.08C(4) Reinstallation and Reconnection

Reinstall monument at new location and reconnect uplights and electrical wiring. Test electrical components to verify proper function.

20-5.08C(5) Finish

Final installation must maintain the existing architectural/visual appearance of the monument.

20-5.08D Payment

Payment for relocating monument shall be lump sum price to relocate existing monument and shall include full compensation for all labor, materials, tools, equipment and incidentals and for doing all work involved in relocating existing monuments, protect monument during construction, remove existing footing, construct new reinforced concrete footing, relocate and reconnect all the existing lights and electrical connection, complete in place as shown on the plans, as specified in these Special Provisions and as directed by the Engineer. No additional compensation will be allowed.

Replace section 20-5.09 with:

20-5.09 DECORATIVE CONCRETE ELEMENTS**20-5.09A General****20-5.09A(1) Summary**

Section 20-5.06 includes general specifications for aesthetic specification on the concrete works shown on the landscape plans.

Refer to the following related section for additional information:

1. Section 28 Concrete Base
2. Section 40 Concrete Pavement
3. Section 51 Concrete Structure
4. Section 73 Concrete Curbs and Sidewalks

Materials and methods of construction shall also comply with the following standards:

1. ASTM International, (ASTM):
 - 1.1. ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.
 - 1.2. ASTM C979 – Pigments for Integrally Colored Concrete.
2. American Concrete Institute, (ACI):
 - 2.1. Specification for Measuring, Mixing and Placing Concrete, (ACI 304)
 - 2.2. Specification for Hot Weather Concreting (ACI 305)
 - 2.3. Specification for Cold Weather Concreting (ACI 306)
 - 2.4. Building Code Requirements for Structural Concrete (ACI 318)
 - 2.5. Specification for Formwork for Concrete (ACI 347)

20-5.09A(2) Definitions

Not Used

20-5.09A(3) Submittals**Mock-up 1:**

Before ordering material for concrete paving, provide sample panel, minimum 4' x 4' of each color and finish, using specified materials. Show color, texture, pattern, edging, and joint treatments. Contractor shall provide additional samples at no additional cost to contract until all colors and finishes have been approved by the Engineer. The approved sample panel may be a portion of the work and remain in place. Location as directed by the Engineer. Contractor will be required to provide additional panels as necessary, until approved.

Mock-up 2:

Before ordering material for concrete paving, provide sample panel, 4' x 1' of each color and finish using specified materials. Show color, texture, pattern, edging, and joint treatments. Contractor shall provide additional samples at no additional cost to contract until all colors and finishes have been approved by the Engineer. The approved sample panel may be a portion of the work and remain in place. Location as directed by the Engineer. Contractor will be required to provide additional panels as necessary, until approved.

20-5.09A(4) Quality Assurance

Not Used

20-5.09B Materials**20-5.09B(1) General**

Not Used

20-5.09B(2) Specialty Concrete Pavement - Type A (Treatment Only)

This item shall consist of furnishing and installing Specialty Concrete Pavement - Type A (Treatment Only) as shown on the Drawings in conformance to Section 19 of the City of Sacramento Standard Specifications and Section 11 of the City of West Sacramento Standard Specifications , and as shown in the plans or as directed by the Engineer.

Refer to section 20-5.08A(1) Submittals for Mock-up 1 requirements.

Pavement Treatment - Type A Color: Pebble (641) Integral Color by Davis Colors (844) 341-4780 per plans or approved equal. If the color does not meet aesthetic standard as determined by the Engineer, the Engineer reserves the right to direct a change in color selection, including adjustment of the Davis Color mix or approved equal.

Pavement Treatment Finish: Top Cast #15 (Medium Exposure).

Sealer: Urethane, SL-TB grade. Apply finish sealer per approved mock-up or as specified to achieve design required.

20-5.09B(3) Specialty Concrete Pavement - Type B (Treatment Only)

This item shall consist of furnishing and installing Specialty Concrete Pavement - Type B (Treatment Only) as shown on the Drawings in conformance to Section 19 of the City of Sacramento Standard Specifications and Section 11 of the City of West Sacramento Standard Specifications, and as shown in the plans or as directed by the Engineer.

Refer to section 20-5.08A(1) Submittals for Mock-up 1 requirements.

Pavement Treatment - Type B Color: Pebble (641) Integral Color by Davis Colors (844) 341-4780 per plans or approved equal. If the color does not meet aesthetic standard as determined by the Engineer, the Engineer reserves the right to direct a change in color selection, including adjustment of the Davis Color mix or approved equal.

Pavement Treatment Finish: Top Cast #3 (Light Exposure).

Sealer: Urethane, SL-TB grade. Apply finish sealer per approved mock-up or as specified to achieve design required.

20-5.09B(4) Stamped Concrete Pattern on Concrete Band

This item shall consist of furnishing and installing Stamped Concrete Pattern on Concrete Band as shown on the Drawings in conformance to Section 19 of the City of Sacramento Standard Specifications and Section 11 of the City of West Sacramento Standard Specifications, and as shown in the plans or as directed by the Engineer.

Refer to section 20-5.08A(1) Submittals for Mock-up 2 requirements.

Pattern: Running Bond Granite Pattern, 6" square, by Bomanite (303) 369-1115

Hardener: Seal Gray by Bomanite.

Sealer: Urethane, SL-TB grade. Apply finish sealer per approved mock-up or as specified to achieve design required.

Refer to manufacture specifications for installation.

20-5.09C Construction**20-5.09C(1) General**

Pavement Treatment: Perform concrete surface treatments using Top Cast Surface Retarder No. 15 for Type A (Medium Exposure) and Top Cast Surface Retarder No. 3 for Type B (Light Exposure) finishes, consistent with the approved mock-ups. Apply Top Cast uniformly to fresh concrete immediately after finishing, following the manufacturer's instructions for coverage rate, temperature conditions, and curing time. Protect treated surfaces

BSM should support plant growth while providing pollutant treatment. BSM will be a mixture of sand, fines, and compost. The following composition includes the measurements for determining the BSM by volume and weight.

<u>BSM Composition</u>	<u>Sand</u>	<u>Sandy Loam</u>			<u>Compost</u>
		<u>Sand</u>	<u>Silt</u>	<u>Clay</u>	
<u>Volume</u>	65%	20%			15%
<u>Weight</u>	75-80%		10% max	3% max	9% max

Biofiltration soil must be a combination of sand, sandy loam, and compost that will support healthy plant growth and achieve an in-place filtration rate of at least 5-inches per hour. No BSM will be delivered without prior written approval by Engineer.

Biofiltration soil must a combination of 65 percent sand, 20 percent sandy loam and 15 percent compost that is uniformly mixed prior to job site delivery.

Sand must:

1. Be clean and free of wood waste, roots, bark, sticks, and rags
2. Be non-plastic
3. Comply with ASTM D3744M and meet durability index of not less than 40
4. Not have any coating such as clay, stone dust, carbonate, and deleterious material
5. Comply with CTM 202 and ASTM C33M

Sand must comply with the gradation requirements shown in the following table:

<u>Sand Gradation Requirements</u>	
<u>Sieve size</u>	<u>Percentage passing</u>
3/8"	100
No. 4	90-100
No. 8	70-100
No. 16	40-95
No. 30	15-70
No. 40 or 50	5-55
No. 100	0-15
No. 200	0-5

Sandy loam must:

1. Be clean and free of wood waste.
2. Comply with ASTM D422 by weight
3. Not have any coating such as clay, stone dust, carbonate, and deleterious material.
4. Clay content does not exceed 15 percent.

A. 50-74 percent sand

B. 0-48 percent silt

C. 1-15 percent clay

Compost must be equal parts mixture of fine and medium particle sizes under section 21-2.02K

Replace Reserved in section 21-2.03R with:

21-2.03R Imported Biofiltration Soil

Mark proposed locations for placement of biofiltration soil. All other earthwork adjacent to biofiltration areas must be completed prior to placement. Final location must be authorized at least 5 business days prior to placement. Excavate and spread out the excavated material throughout the job site in compliance with section 19. Do not compact subgrade under biofiltration swale or strip.

Do not excavate, place soils, or amend soils during wet or saturated conditions.

Operate equipment adjacent to the facility. Equipment operation within the project site will be avoided to prevent soil compaction. If machinery must operate on site, use lightweight, low ground-contact pressure equipment.

Consider time of year and site working area. BSM will be mixed prior to being delivered to the site. Mixing on-site will not allowed.

The subgrade of the infiltration facility will be ripped or scarified to a minimum dept of 9 inches on 3-foot centers to promote greater infiltration.

Place biofiltration soil in lifts of 6 to 12 inches. Lifts must be watered and lightly tamped down. Edges of the biofiltration area must be level with the finished grade of surrounding area. If biofiltration area has settled, refill with additional biofiltration material.

To avoid over compacting place first lifts at far end from entrance and place backwards towards the entrance. Allow BSM lifts to settle naturally, lightly water to provide settlement and natural compaction between lifts. After lightly watering, allow soil to dry between lifts. Do not work in saturated conditions. After all lifts are placed, wait 5 days to check for settlement, and add additional media as needed. No mechanical compaction is allowed.

Vehicular traffic and construction equipment will not be allowed onto or disturb the BSM once placed and water compacted.

Rake bioretention soil as needed to level out. Verify BSM elevations before applying compost blanket or installing plants.

21-2.03R D Payment

Payment for Imported Biofiltration Soil Mix will be made at the contract unit price per square foot (SF). The payment includes full compensation for furnishing all labor, materials, equipment, and incidentals necessary to complete the work.

Replace section 20-2.14 with:

20-2.14 TEMPORARY IRRIGATION SYSTEMS

20-2.14A General

20-2.14A(1) Summary

Provide a temporary irrigation system to support the germination and establishment of hydroseeded areas for a period of up to 3 months after installation. The temporary irrigation system may be supplied from the proposed permanent irrigation system, if available. The Contractor is responsible for identifying connection points and routing temporary irrigation components. If trenching, coring, tapping, or drilling into any existing or proposed improvements is required, submit written notice and obtain approval from the Engineer prior to performing the work.

20-2.14A(2) Definitions

The temporary irrigation system may consist of either:

1. Hand-watering, or
2. A temporary drip irrigation layout to provide sufficient moisture for germination.

Water trucks are not permitted for routine irrigation.

The temporary irrigation system must not interfere with traffic or construction activity and must be removed at the end of the establishment period unless otherwise directed.

20-2.14A(3) Submittals

5. Use if the Contractor will design the temporary irrigation system.

Submit a seasonal watering plan and schedule for approval at least 10 days before use of the temporary irrigation system. Allow 5 days for the Engineer's review and approval.

20-2.14A(4) Quality Assurance

Not Used

20-2.14B Materials

Use commonly available drip irrigation components or hoses suitable for temporary use. No specific pipe material, valve assemblies, or control units are required unless shown on the Plans. Materials need not meet permanent irrigation specifications.

20-2.14C Construction

Install temporary irrigation equipment as needed to provide uniform moisture to hydroseeded areas during the establishment period. Maintain irrigation system operation to avoid oversaturation, erosion, or water waste. Remove temporary irrigation equipment at the conclusion of the establishment period or when directed by the Engineer. Restore disturbed ground and backfill trenches as necessary.

20-2.14D Payment

Payment for Temporary Irrigation System will be made at the Lump Sum (LS) price bid. The lump sum payment includes full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the work. No additional compensation will be allowed.

Add to section 21-2.02:**21-2.02T Hydroseed Type 1 (Wildflower Mix)**

This item shall consist of furnishing and installing Hydroseed Type 1 (Wildflower Mix) as shown on the Drawings in conformance to the provisions of Sections 35-10 (Hydro-Seed placement) of the City of Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of City of West Sacramento Standard Specification and Plans.

Materials: The typical hydroseed mixture shall contain seed mix type 1, Promatrix BFM, Hydropost premium compost, fertilizers as indicated on the drawings. The hydroseed materials shall be mixed uniformly and applied in the proportions to all areas per plan.

21-2.02U Hydroseed Type 2 (Native Grass Mix)

This item shall consist of furnishing and installing Hydroseed Type 2 (Native Grass Mix) as shown on the Drawings in conformance to the provisions of Sections 35-10 (Hydro-Seed placement) of the City of Sacramento Standard Specifications and Plans and Section 16 (Landscaping) of City of West Sacramento Standard Specification and Plans.

Materials: The typical hydroseed mixture shall contain seed mix type 2, Promatrix BFM, Hydropost premium compost, fertilizers as indicated on the drawings. The hydroseed materials shall be mixed uniformly and applied in the proportions to all areas per plan.

21-2.02V Imported Topsoil (24" Deep)

This item shall consist of furnishing and installing Imported Topsoil as shown on the plans in conformance with the applicable paragraphs of Sections 10, 14, and 35 of the City of Sacramento Standard Specifications, Section 16 (Landscaping) of West Sacramento Standard Specifications and these Special Provisions.

Imported topsoil shall be a homogeneous mineral soil classified as sandy loam, or fine sand. Particle size data shall be based upon standard USDA methodology. Of the material falling in the sand category, a minimum of 80% shall fall in the fine sand range .05 - 5mm. Gravel content greater than 2.0mm shall be less than 15%. Import topsoil shall not contain more silt and clay than the on-site native soil. The sum of silt plus clay shall be less than 25%; the soil shall be nonsaline as determined on the saturation extract. Salinity shall not exceed 3.0 mmhos/cm, boron shall not exceed 1.0 ppm and the sodium absorption ratio (SAR) shall not exceed 6.0. Soil reaction as determined on a saturated paste shall fall between 5.5 and 7.5. The soil shall be free of organic herbicides, or other growth-restricting chemicals. Contamination may be tested by greenhouse trials using rye grass and radish as test crops using the proposed import soil as substrate. These trials require four to five weeks for completion.

Payment for hydroseed Type 1 (wildflower mix) shall be at the unit price bid per square foot and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in hydroseeding of landscaped areas, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

Payment for imported topsoil (24" deep) shall be at the unit price bid per cubic yard and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in import topsoil, as shown on the Plans, as specified in these Special Provisions, and as directed by the Engineer.

Replace the second paragraph of section 39-2.01D with:

Replace section 39-2.02A(3)(b) with:

Hot mix asphalt Type A mix design must comply with section 22 of the City Standard Specifications.

For Type A HMA using RAP substitution of greater than 15 percent of the aggregate blend, the virgin binder grade must comply with the PG binder grade specified above with 6 degrees C reduction in the upper and lower temperature classification.

Replace the 1st paragraph of section 39-2.02B(4)(b) with:

Use 3/4" maximum aggregate gradation of hot mix asphalt Type A.

39-3.04 COLD PLANNING ASPHALT CONCRETE PAVEMENT

Cold planning asphalt concrete pavement shall be per square yard for cold plane asphalt concrete pavement and shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cold planing asphalt concrete surfacing and disposing of planed material and pavement reinforcement fabric, including constructing, maintaining, removing temporary hot mix asphalt concrete tapers if applicable, as specified in the City Standard Specifications, these Special Provisions and as directed by the Engineer.

45 GENERAL

Submit documentation that the manufacturer meets the experience requirements herein.

If requested, submit records of dimensional inspections and any shop assembly fit-up tests.

45-2.01D Quality Assurance

The manufacturer must have at least five years' experience manufacturing FRP gratings.

Utilize a manufacturer that is ISO 9001 certified.

45-2.02 MATERIALS

45-2.02A General

Mark panels for identification and match-marking with permanent ink or weather-resistant tags.

Provide molded or pultruded FRP grating comprised of vinyl ester or polyester resin with flame retardant and UV inhibitor additives.

Provide grating with fire performance meeting a flame spread rating of 25 or less in accordance with ASTM E84, the flammability characteristics of UL94 V-0, and the self-extinguishing requirements of ASTM D635.

Provide grating that is grey in color.

Provide a synthetic surface veil fabric that encases the glass reinforcement. After fabrication, Seal all cut ends, holes, and abrasions with a compatible resin coating.

Provide an anti-slip surface affixed to the top surface of the grating that conforms to a Wear Index of less than 10.0 when tested according to ASTM D4060.

Use stainless steel anchorages that are provided by the manufacturer.

45-2.02B Delivery, Storage, and Handling

During transport and storage, support and protect panels to prevent distortion, cracking, chipping, or damaging the grating.

Palletize and band grid panels and protect exposed edges to prevent damage during transport.

Store panels off the ground using timber blocking. Place blocking at points to prevent sagging.

Use nylon slings or other non-abrasive lifting devices to avoid damaging the panels.

45-2.03 CONSTRUCTION

Take field measurements prior to preparation of final shop drawings and fabrication to ensure proper fit of work.

Prior to installation, inspect supports for correct alignment and conditions for proper attachment of the grating.

Install grating in accordance with the manufacturer's installation instructions.

Seal all field cut and drilled edges, holes, and abrasions with a resin compatible with the original resin, as recommended by the manufacturer.

Repair damage to grating in accordance with the manufacturer's instructions and at no additional cost.

45-2.04 PAYMENT

Payment will be made at the contract unit price per square foot of fiber reinforced grating. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to complete the fiber reinforced grating as shown on the plans and as described herein.

Payment quantity for fiber reinforced grating is the gross surface area of the fiber reinforced grating installed and inspected, as measured from the outside edge to the outside edge of the fiber reinforced grating in both directions. Do not deduct joints, block-outs, or openings.

Replace section 45-3 with:
45-3 EXODERMIC BRIDGE DECK

45-3.01 GENERAL**45-3.01A Summary**

Section 45-3 includes fabricating, delivering, and installing the exodermic bridge deck.

Exodermic bridge deck includes any miscellaneous metal forms (or other related forming materials), reinforcing steel, and structural concrete.

The grating support angle and connecting studs are not included in this work.

45-3.01B Definitions

exodermic bridge deck: A thin reinforced concrete slab on top of and composite with an open steel grid deck. Concrete is above the grid cross bars.

45-3.01C Submittals

Submit weld qualifications and weld procedures to the Engineer for approval prior to commencing work.

Submit a concrete mix design to the Engineer for approval prior to commencing work.

Submit the name, address, telephone number, and contact person of the fabricator of all steel grid deck panels within 10 days after award of contract.

Submit shop drawings showing panel dimensions, bar spacing, form pan placement, panel layout, and panel identification marks to the Engineer for approval prior to commencing work.

45-3.01D Quality Assurance

Not Used

45-3.02 MATERIALS**45-3.02A Steel Grid Deck**

Verify all dimensions shall be field verified prior to fabrication.

Fabricate the main bearing bars of the steel grid deck from WT structural shapes using ASTM A992/A992M steel.

Fabricate the distribution bars and miscellaneous plates to meet the requirements of ASTM A572/A572M Grade 50 or ASTM A709/A709M Grade 50 steel.

Perform welding in accordance with AASHTO/AWS D1.5M/D1.5 and established grid industry practice, including the use of Gas Metal Arc Welding (MIG).

After the attachment of edge bars, leveling devices, vertical form pans, and other components described in the plans and specifications, galvanize the steel grid deck in accordance with ASTM A123/A123M. Repair any defects in galvanizing shall according to ASTM A780/A780M. Do not use repair materials containing aluminum to restore defective areas.

Provide leveling bolts conforming to ASTM A307, nuts conforming to ASTM A563/A563M, and washers conforming to ASTM F844, unless noted otherwise. Galvanize leveling bolts, nuts, and washers according to ASTM F2329/F2329M

Protect all sheet metal form pans during shipment and site storage to retain their shape until installation.

Install vertical steel sheet metal form pans in the steel grid deck prior to galvanizing. Provide vertical steel sheet metal form pans conforming to ASTM A366/A366M or ASTM A1011/A1011M. Install all other sheet metal form pans after steel grid deck galvanizing. Galvanize all other sheet metal form pans in accordance with ASTM A653/A653M prior to installation in the steel grid deck.

Install sheet metal form pans in a manner to minimize leakage.

Fabricate the steel grid deck to the dimensions and properties shown in the shop drawings and in accordance with section 55. Do not use tertiary or supplemental bars to develop composite action between the concrete deck and steel grid deck. Provide weld sizes conforming to the established grid industry practice, unless noted otherwise.

Fabricate the steel grid deck panels in accordance with the following tolerances:

<u>Panel Length (L)</u>	<u>$\pm 0.25"$ (in the direction of main bar)</u>
<u>Panel Width (W)</u>	<u>$+0, -0.125"$ (in the direction of distribution bar)</u>
<u>Squareness (Diagonals 'D1' and 'D2')</u>	<u>$D1-D2 \leq 0.5"$</u>
<u>Longitudinal Camber</u>	<u>$0.003*L$</u>
<u>Transverse Camber</u>	<u>$0.004*W$</u>
<u>Sweep (side bow)('L' in feet, tolerance in inches)</u>	<u>$0.025*L$ (for $L \leq 40'-0"$) $0.00065*L^2$ (for $L > 40'-0"$)</u>
<u>Main Bar Verticality</u>	<u>$0.04*H$ ('H' = full bar height) (See Note 1)</u>
<u>Distribution Bar Verticality</u>	<u>$0.04*H$ ('H' = full bar height) (See Note 1)</u>
<u>Bar Spacing (Main Bar and Distribution Bar)</u>	<u>$\pm 0.125"$ (See Note 1)</u>

Note 1: No more than 1% of all locations can violate specified tolerance.

Place leveling devices to provide adequate clearances for field adjustment from above and for adequate clearance for field placement of headed shear studs.

Deliver steel grid deck panels to the job site free from any defects and bearing the proper identifying marks. Repair or replace steel grid deck panels or metal form pans damaged during shipment and storage to the satisfaction of the Engineer.

45-3.02B Concrete

Provide concrete with a 28-day compressive strength of 4,000 psi and a maximum coarse aggregate size of 3/8" conforming to section 51.

Place all concrete in the field.

Provide reinforced concrete with a unit weight of 100 pcf.

Concrete must conform to Section 51-1.02B for concrete bridge decks.

45-3.02C Bar Reinforcing Steel

Provide reinforcing steel conforming to ASTM A615/A615M Grade 60 and section 52.

45-3.03 CONSTRUCTION

Install exodermic bridge deck in accordance with the plans and the most recent version of BGFMA TS-03, "Installation Tolerances and Guidelines for Grid Reinforced Concrete Bridge Decks," published by the Bridge Grid Flooring Manufacturers Association.

Position steel grid deck panels on the beams and align with adjacent panels. Take measurements from fixed points to avoid cumulative error. Adjust elevation using the built-in leveling bolts, shims, or other means. Square-up panels as necessary.

After all haunch and miscellaneous forms have been installed, install the shear studs on the steel stringers, girders, and/or floor beams through the openings provided in the steel grid deck panels. Shear studs may alternatively be welded prior to placing steel grid deck panels with the Engineer's approval. Use a separate generator to provide power to each stud gun to ensure acceptable welds.

After all shear studs have been installed, clean the top surface of all flanges before any concrete is placed, including breaking the ceramic ferrules around the shear studs.

Field seal any gaps between the main bars and the horizontal form pans using silicone caulk to prevent excessive concrete and grout leakage.

At haunches and areas of full-depth concrete, seal the opening in the main bars using duct tape or other similar material prior to concrete placement. Seal the openings from the haunch or full-depth side.

Do not place concrete until all steel grid deck panels are secured in their proper place on the bridge and all shear studs and reinforcing steel are installed. Place main (top, running in same direction as the main bearing bars) reinforcing steel a minimum of 1" from the web of the main bearing bars.

Place, finish, and cure concrete in accordance with the deck pouring sequence shown on the plans and section 51. Use a pencil vibrator in the haunch and full-depth areas between steel grid deck panels for proper consolidation.

Coat vertical surfaces of all construction joints with a Portland cement mortar bonding grout.

Wash any drips off the deck during concrete pouring using a high-pressure water hose. Do not disturb the sheet metal form pans with the high-pressure steam.

Texture the bridge deck surface longitudinally by grinding and grooving in accordance with section 51-1.03F(5)(b)(ii).

Replace damaged or defective concrete in accordance with section 51.

45-3.04 PAYMENT

Payment will be made at the contract unit price per square foot of exodermic bridge deck. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the exodermic bridge deck, including all transportation, storage, and protection of the deck panels as shown on the plans and as described herein.

The grating support angle and connecting studs are not included in this work.

Payment quantity for exodermic bridge deck is the gross surface area of the exodermic bridge deck installed and inspected, as measured from the outside edge to the outside edge of the exodermic bridge deck in both directions. Do not deduct joints, block-outs, or openings.

49 PILING

Add to section 49-1.03:

Expect difficult pile installation due to the conditions shown in the following table:

Pile location		Conditions
Bridge no.	Support location	
<u>22C0193</u>	<u>Abutments 1 and 6</u> <u>Piers 2,3,4, and 5</u>	<u>Difficult conditions to install the casing and excavate CIDH piles, including dense gravel and cobbles below the groundwater table as identified in the log of test borings.</u>
<u>RW No. 2</u>	<u>All Pile Locations</u>	<u>Difficult pile installation conditions due to saturated loose sand present below the water table.</u>

Add to section 49-3.02A(1):

The CIDH concrete piles shown in the following table are specified as end bearing:

Bridge name or no.	Abutment no.	<u>Pier no.</u>
<u>22C0193</u>	<u>N/A</u>	<u>3 and 4</u>

Replace section 49-3.02A(3)(a) with:**49-3.02A(3)(a) General**

Submit as an informational submittal the proposed drilling equipment operational capacities or descriptions for:

1. Downward force in lb
2. Torque in ft-lb
3. Rotational speed in rpm
4. Rate of penetration in ft/hr
5. Number and type of drilling cutters or drilling teeth on drilling tool

Add to section 49-3.02A(3):**49-3.02A(3)(l) Experience Qualifications**

At least 15 days before the start of CIDH concrete pile construction, submit as an informational submittal the following experience qualifications in compliance with section 49-3.02A(4)(f):

1. List of CIDH concrete pile installations performed by the drilling contractor. The submittal must include:
 - 1.1. Project description
 - 1.2. Name and phone number of the owner
 - 1.3. CIDH pile plans
 - 1.4. Log of test borings
 - 1.5. Estimated dates of major CIDH pile installation activities
 - 1.6. CIDH pile acceptance testing reports
2. List of on-site foremen and drill rig operators who will perform the CIDH concrete pile work and a summary of each individual's experience. The submittal must include:
 - 2.1. Detailed summary of each individual's experience in CIDH pile excavation operations and placement of assembled reinforcing cages and concrete
 - 2.2. Experience from at least 3 relevant projects, including:
 - 2.2.1. Project Description
 - 2.2.2. Date of work
 - 2.2.3. Actual work performed
 - 2.2.4. Name and phone number of a reference person for each project
 - 2.3. Proof of on-site foremen and drill rig operators experience qualifications
 - 2.4 [Geotechnical oversight engineer qualifications for levee work](#)

Add to section 49-3.02A(4):**49-3.02A(4)(f) Experience Qualifications**

The drilling contractor must have successfully constructed at least 3 separate foundation projects in the last 5 years. The foundation projects must:

1. Have CIDH piles of similar or larger diameter and depth, and installed under similar substructure conditions to this contract
2. Demonstrate experience with drilling fluids and successful construction of CIDH piles under the wet conditions

Each on-site foremen and drill rig operator must have 2 years of experience installing CIDH concrete piles on at least 3 projects. The CIDH pile foundations must be of similar or larger diameter and depth, and installed under similar subsurface conditions to this contract.

On-site foremen experience must be supervising construction of CIDH concrete pile foundations. Indirect supervision of on-site CIDH concrete pile construction operations is not acceptable.

Drill rig operator experience must be in construction of CIDH concrete pile foundations.

Add section 49-3.02A(5):**49-3.02A(5) US Army Corps of Engineer Requirements****49-3.02A(5)(a) Contractor Experience Requirements for Drilled Shaft Installation in Levee**

The contractor must comply with the guidelines set forth in ER 1110-1-1807.

On-site personnel must be experienced in drilling methods and operations with knowledge of potential difficulties to prevent and/or minimize adverse conditions that may arise during drilling.

Drill rig operators must have a minimum of 3 years of experience drilling with the type of equipment proposed on at least two dam and/or levee projects and be familiar with the guidelines described in ER 1110-1-1807. The drill rig operator and field supervisors must also be familiar with the USACE guidelines and the issues that can cause adverse impacts.

The Contractor must demonstrate the capability in the following aspects of drilled shaft construction:

1. Mobilization and setup of drilling equipment in levee environments
2. Installation of temporary casings
3. Use of drilling slurry (e.g., bentonite or polymer) for shaft stability
4. Placement of reinforcement cages and tremie concrete

49-3.02A(5)(b) Submittals

Submit details about on-site personnel including qualifications and/or experience with the installation of drilled shafts.

Submit at least 2 example projects. Example projects provided must include documentation such as contract excerpts (not to exceed 5 pages per project) demonstrating:

1. Shaft diameter, depth and quantity
2. Site conditions and mitigation measures used during construction
3. Drilling methods
4. Tremie concrete placement
3. Quality control procedures

49-3.02A(5)(c) Engineer/Geologist

A Professional Engineer or Geologist licensed in the State of California, with a minimum of 5 years of experience on similar projects, must be present on-site to provide inspection of excavations and soil/groundwater conditions throughout construction and other technical experts with experience as required in ER 1807[1]. The Engineer or Geologist is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Engineer or Geologist must provide weekly written reports informing the Army Corps and Construction Manager of the status of the excavations and an accounting of any present or potential problems the Contractor may have encountered. The Engineer or Geologist must be available to meet with Army Corps and Construction Manager upon request throughout the contract duration.

Add to section 49-3.02B(6)(c):

The synthetic slurry must be one of the materials shown in the following table:

Material	Manufacturer
SlurryPro CDP	KB INTERNATIONAL LLC 735 BOARD ST STE 209 CHATTANOOGA TN 37402 (423) 266-6964
Super Mud	PDS CO INC 105 W SHARP ST EL DORADO AR 71731 (870) 863-5707
Shore Pac	CETCO 2870 FORBS AVE HOFFMAN ESTATES IL 60192 (800) 527-9948
Terragel or Novagel Polymer	GEO-TECH SERVICES LLC 220 N. ZAPATA HWY STE 11A-449A LAREDO TX 78043 (210) 259-6386
BIG FOOT	MATRIX CONSTRUCTION PRODUCTS 50 S MAIN ST STE 200 NAPERVILLE IL 60540 (877) 591-3137
POLY-BORE	BAROID INDUSTRIAL DRILLING PRODUCTS 3000 N SAM HOUSTON PKWY EAST HOUSTON TX 77032 (877) 379-7412

Use synthetic slurries in compliance with the manufacturer's instructions. Synthetic slurries shown in the above table may not be appropriate for a given job site.

Synthetic slurries must comply with the Department's requirements for synthetic slurries to be included in the above table. The requirements are available from:

OFFICES OF BRIDGE DESIGN
P.O. BOX 168041
MS# 9-4/11G
SACRAMENTO, CA 95816-8041

SlurryPro CDP synthetic slurry must comply with the requirements shown in the following table:

SlurryPro CDP

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	$\leq 67.0^a$ $\leq 64.0^a$
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	50–120 ≤ 70
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

Super Mud synthetic slurry must comply with the requirements shown in the following table:

Super Mud

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	$\leq 64.0^a$ $\leq 64.0^a$
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	32–60 ≤ 60
pH	Glass electrode pH meter or pH paper	8.0–10.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

Shore Pac synthetic slurry must comply with the requirements shown in the following table:

Shore Pac

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	$\leq 64.0^a$ $\leq 64.0^a$
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	33–132 ≤ 118
pH	Glass electrode pH meter or pH paper	8.0–11.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

Terragel or Novagel Polymer synthetic slurry must comply with the requirements shown in the following table:

Terragel or Novagel Polymer

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	$\leq 67.0^a$ $\leq 64.0^a$
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	45–104 ≤ 104
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

BIG-FOOT synthetic slurry must comply with the requirements shown in the following table:

BIG-FOOT

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	$\leq 64.0^a$ $\leq 64.0^a$
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	30–125 55–114
pH	Glass electrode pH meter or pH paper	8.5–10.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

POLY-BORE synthetic slurry must comply with the requirements shown in the following table:

POLY-BORE

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	62.8–65.8 ^a 62.8–64.0 ^a
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	50–80 50–80
pH	Glass electrode pH meter or pH paper	7.0–10.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

^aIf authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

Replace section 49-3.02B(6)(d) with:

49-3.02B(6)(d) Water Slurry

You may use water as slurry if a casing is used for the entire length of the drilled hole.

Water slurry must comply with the requirements shown in the following table:

Water Slurry Requirements

Quality characteristic	Test method	Requirement
Density: Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	63.5 ^a
Sand content: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 0.5

^aIf authorized, you may use salt water slurry. The allowable density of the slurry may be increased by 2 pcf.

Add to section 49-3.02C(1):

Drilling equipment must be equipped with instrumentation to accurately measure the downward force in pounds. The instrumentation dial or display must be clearly visible for reading during operation.

Add to section 49-3.02C(3):

Temporary steel casings are required at Br No. 22C0193 abutments 1 and 6, and piers 2, 3, 4 and 5 during CIDH pile construction to a minimum elevation of -65 ft.

Install temporary steel casings by oscillators or rotors.

Add to section 49-3.02C(4):

If the hole is drilled below the specified tip elevation shown, the reinforcement must extend to within 3 inches of the bottom of the drilled hole for the piles that are specified as end bearing.

Add to section 49-3.02C(6):

Install permanent steel casings by oscillators or rotators.

Replace item 5 in the list in the 2nd paragraph of section 49-3.02C(7) with:

5. Be installed by oscillators or rotators.

51 CONCRETE STRUCTURES

Add to section 51-1.01A:

The portions of the bridges shown in the following table must be constructed as mass concrete under section 51-6:

Bridge name and number	Portion of bridge
I Street Bridge Replacement (22C0193)	Abutment 1 & 6 Pile Caps
I Street Bridge Replacement (22C0193)	Piers 3 and 4 Pile Caps
I Street Bridge Replacement (22C0193)	Piers 3 and 4 Tower Corbels

Replace the 1st Paragraph of section 51-1.01A:

Section 51-1 includes general specifications for constructing concrete structures and railing monument.

Add to section 51-1.01C(1):

If the methacrylate crack treatment is applied to a bridge deck within 100 feet of a residence, business, or public space, submit a public safety plan. Include with the submittal:

1. Copy of public notification letter with a list of delivery addresses and posting locations. The letter must describe the work to be performed and state the treatment work locations, dates, and times. Deliver copies of the letter to residences and businesses within 100 feet of the treatment work and to local fire and police officials, at least 7 days before starting treatment activities. Post a copy of the letter at the job site.
2. Airborne emissions monitoring plan. Plan must include monitoring point locations. A CIH certified in comprehensive practice by the American Board of Industrial Hygiene must prepare and execute the plan.
3. Action plan for protecting the public if levels of airborne emissions exceed permissible levels.
4. Copy of the CIH's certification.

After completing methacrylate crack treatment activities, submit results from monitoring production airborne emissions as an informational submittal.

Replace the 2nd paragraph of section 51-1.01C(1) with:

Submit a deck placement plan for concrete bridge decks. Include in the placement plan your method and equipment for ensuring that the concrete bridge deck is kept damp by misting immediately after finishing the concrete surface.

Replace section 51-1.01D(1) with:

51-1.01D(1) General

The job site must have at least 4 airborne emissions monitoring points, including the mixing point, application point, and point of nearest public contact. Monitor airborne emissions during methacrylate crack treatment activities.

Replace section 51-1.02D(2)(a) with:

Develop a plan to monitor the plumbness of the piers and towers during placement of concrete. Employ a Licensed Surveyor registered in the State to write and execute the monitoring plan.

Submit monitoring plan to the Engineer for approval prior to commencing work on the piers.

Add to section 51-1.02G:

For façade anchorages, provide pre-packaged non-shrink grout conforming to ASTM C1107/C1107M. Provide grout that is non-metallic, non-staining, capable of achieving a minimum compressive strength of 8,000 psi at 28 days, and suitable for vertical or overhead placement without sagging.

Add to section 51-1.02:**51-1.02K Railing Monument:**

Stainless steel for the Monument Emblem and lettering on the monument must comply with ASTM A240/A240M, Type 316 and is subject to AESS category 3 for visible surfaces.

Aluminum angles must comply with ASTM B308/B308M.

Light diffusing acrylic lens must be "Plaskolite 2406", "ACRYLITE SG 65 White WDR58 DF", or approved equal and have 68% light transmission.

Anchors, fasteners, screws and other fittings must be commercial quality.

51-1.02L Bat Emblem:

Stainless steel for the Bat Emblem must comply with ASTM A240/A240M.

Studs must comply with section 75.

Add to section 51-1.03D(1):

Construct Pier 3 and Pier 4 with an allowable deviation from plumb of 1:1000 or 1/2" as measured from the top of the pier cap footing to the top of the tower.

Notify the Engineer if maximum allowable deviation from plumb has been exceeded. Do not commence work until further direction from the Engineer.

Add to section 51-1.03D:**51-1.03D(8) Façade Anchorages**

Coordinate location of façade anchorages with the façade.

Façade anchor bolts must be accurately positioned and securely held in place during concrete placement or curing of grout using approved templates or supports.

Install façade anchor bolts to the alignment, embedment depth (where applicable), and orientation shown on the plans.

Provide grout pockets as shown on the plans. Place grout according to the manufacturer's instructions. Ensure that grout fills the space shown in the plans without any air bubbles or pockets, but does not extend beyond the edges of the base plates.

Replace the 1st paragraph of section 51-1.03F(5)(b)(i) with:

Except for bridge widenings, texture the bridge deck surfaces longitudinally by grinding and grooving.

Add to section 51-1.04:

The Payment for Structural Concrete, Bridge (Approach Structures) includes the Bat Emblems.

Replace section 51-3.04 with:**51-3.04 ISOLATION BEARING****51-3.04A GENERAL****51-3.04A(1) Summary**

Section 51-3.04 includes furnishing and testing prototype isolation bearings.

This section also includes designing, furnishing, testing, and installing production isolation bearings.

51-3.04A(2) Definitions

The definitions and notation given below apply to these provisions:

DL: Dead load including additional dead load (DW)

D_t: Thermal displacement

DT: Maximum lateral seismic bearing displacement

D_{tr}: Maximum non-seismic transverse displacement

EDC: Energy dissipated per cycle

EQD: Earthquake axial load down due to overturning (per bearing)

F_t: Maximum thermal lateral load

F_{tr}: Maximum non-seismic transverse lateral load

GSSID: AASHTO Guide Specifications for Seismic Isolation Design, 4th edition, 2014

Isolation bearings: Lead core rubber bearings with affixed steel plates, anchorage devices and grout pads.

K_d: Post-elastic stiffness

K_{eff}: Effective stiffness

K_u: Elastic stiffness

LL: Vertical live load (HL-93) including impact

T: Period of seismically isolated structure in the direction under consideration

51-3.04A(3) Submittals

Submit shop drawings for prototype and production bearings to the Engineer.

Within sixty (60) days of contract award, submit shop drawings for prototype bearings. Allow forty-five (45) days for review.

Provide shop drawings and design calculations signed by Professional Engineer registered in the State of California.

Include the following in the shop drawings for the prototype bearings:

1. Bearing details, including:
 1. Material types and specifications
 2. Exterior dimensions, including dimensions of each component and holes for anchorages
 3. Material property modification factors for aging, velocity, contamination, travel (wear), and temperature
2. Prototype testing protocols and acceptance criteria
3. Testing information including:
 1. Material testing
 2. Bearing prototype test procedures and apparatus.
4. Detailed supplemental calculations and commentary including:
 1. The anticipated energy dissipated per cycle (EDC)

2. Fully defined hysteresis loop
3. Supporting calculations for the bearing design and for all variables as shown on the "Isolation Bearing Performance Criteria" table of the design criteria.
4. Vertical stiffness of bearing under service loads as described in the Stability Criteria
5. Bearing maintenance recommendations including schedule for routine inspection

After prototype bearing shop drawings are authorized and prototype testing is complete, and prototype bearing test report has been approved, submit shop drawings for production bearings.

Include the following in the shop drawings for the production bearings:

1. Exterior dimensions of bearings, including dimensions of each component and holes for anchorages in the bearing.
2. Specific anchorages to be used.
3. Dimensions and attachments of bevel plates, shim plates, casing cap assembly.
4. Dimensions and all components connecting isolation bearings to superstructure and substructure.
5. Redlined modifications to the authorized shop drawings for prototype bearings, if applicable.
6. Mix design for grout. Means and methods for furnishing, placing, and curing grout.

Submit the inspection and maintenance manual. Include the following in the inspection and maintenance manual:

1. Complete step-by-step inspection procedures for the bearings, including the recommended frequency of inspection. Include specific observations to be made and the acceptable range of values
2. Complete step-by-step maintenance requirements for the bearings, including recommended frequency of maintenance
3. Contact and telephone number for maintenance questions
4. Separate section detailing recommended post-earthquake inspection and maintenance.

Submit the test results for each bearing. Include the following in the test results:

1. Bearing number
2. Names of personnel performing the tests and interpreting the test results
3. Date and time of testing
4. Test equipment
5. Methods, loads, cycle frequencies, and displacement results
6. Fully defined hysteresis loop for each bearing including results for all variables as shown on the "Isolation Bearing Performance Criteria" table
7. Results for the tests required under Quality Assurance herein. Include tested values for the requirements shown under Testing Acceptance Criteria

51-3.04A(4) Quality Assurance

Within ten (10) days of contract award, contact the Caltrans Seismic Response Modification Device (SRMD) Testing Facility at University of California, San Diego (UCSD) to schedule testing. Notify the Engineer of testing schedule at least thirty days prior to the testing.

The Engineer must be present during prototype testing, proof testing, and installation of all isolation bearings.

Ensure that the manufacturer's representative is:

1. Present during prototype testing
2. Present during proof testing
3. Present during the first two (2) installations
4. Available during remaining installations

The representative must not be the Contractor's employee.

Do not use prototype bearings as production bearings.

All production bearings must pass the proof testing.

51-3.04A(5) Quality Control

51-3.04A(5)(a) Prototype Testing

Provide two full-size bearings for prototype testing and deliver to the testing facility.

Perform prototype testing at the "Seismic Response Modification Device Test System" (SRMD) on the University of California, San Diego campus, telephone (858) 534-1432, unless otherwise specified or authorized by the Engineer.

Test each prototype bearing in two directions 90 degrees apart.

Perform prototype testing under the test methods and conditions shown in the following table:

Prototype Testing

<u>Test methods</u>	<u>Conditions</u>			
	<u>Vertical load shown (kips)</u>	<u>Minimum cyclic displacement (inches)</u>	<u>Number of cycles</u>	<u>Peak velocity (inches per second)</u>
<u>GSSID 13.2.2.1—thermal PT-A1</u>	<u>DL</u>	<u>± D_{tr}</u>	<u>3</u>	<u>No less than 0.00005</u>
<u>GSSID 13.2.2.2—wind and braking: pre-seismic test PT-B1</u>	<u>DL</u>	<u>± D_{tr}</u>	<u>20</u>	<u>Corresponding to period of 2 seconds per cycle and hold the displacement for 1 minute at the end</u>
<u>GSSID 13.2.2.3—seismic PT-C1</u>	<u>DL</u>	<u>± DT</u>	<u>3</u>	<u>Same as that of proof testing</u>
<u>GSSID 13.2.2.3—seismic PT-C2</u>	<u>DL</u>	<u>± 0.25 × DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.3—seismic PT-C3</u>	<u>DL</u>	<u>± 0.5 × DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.3—seismic PT-C4</u>	<u>DL</u>	<u>± 0.75 × DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.3—seismic PT-C5</u>	<u>DL</u>	<u>± 1.0 × DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.3—seismic PT-C6</u>	<u>DL</u>	<u>± 1.25 × DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.4—wind and braking: post-seismic test PT-D1</u>	<u>DL</u>	<u>± D_{tr}</u>	<u>3</u>	<u>Corresponding to period of 13.3 seconds per cycle and hold the displacement for 1 minute at the end</u>
<u>GSSID 13.2.2.5—seismic performance verification PT-E1</u>	<u>DL</u>	<u>± DT</u>	<u>3</u>	<u>--</u>
<u>GSSID 13.2.2.6—stability PT-F1</u>	<u>1.2 × DL + EQD</u>	<u>1.5 × DT</u>	<u>1</u>	<u>--</u>
<u>GSSID 13.2.2.6—stability PT-F2</u>	<u>0.8 × DL - EQD</u>	<u>1.5 × DT</u>	<u>1</u>	<u>--</u>

Notes:

1. Test methods are found in AASHTO Guide Specifications for Seismic Isolation Design (GSSID).
2. Conduct tests with fully reversed sinusoidal cycles at a peak velocity corresponding to the period of the isolated structure, T, unless noted otherwise.
3. Cool down bearing per manufacturer's recommendation between each test.
4. Dead Load (DL) corresponds to the load during service when the bridge is in the closed position.

Ensure the ambient temperature of the testing facility is 65 degrees F $\pm$ 15 degrees at the start of the test.

Before testing, condition the bearings for 12 hours at 65 $\pm$ 15 degrees F. A temperature of 65 $\pm$ 5 degrees F shall be maintained during the bearing testing.

For each cycle of the test, continuously record the load, displacement, and hysteretic behavior for the specimens.

Continuously monitor the bearings.

Provide signatures on the reports of the personnel conducting the testing.

Allow twenty (20) days for review of test results. Do not commence fabrication of the production bearings until prototype test results are approved by the Engineer.

51-3.04A(5)(b) Proof Testing

Proof test the production bearings under the test methods and conditions shown in the following table:

<u>Test Methods</u>	<u>Proof Testing</u> <u>Conditions</u>		
	<u>Vertical Load</u> <u>(kips)</u>	<u>Minimum Cyclic</u> <u>Displacement</u> <u>(inches)</u>	<u>Number of Cycles</u>
<u>GSSID 15.2.1—compression capacity</u>	<u>$1.5 \times (DL + LL)$</u>	<u>0</u>	<u>One 5 minute sustained load</u>
<u>GSSID 15.2.2—combined compression and shear</u>	<u>DL</u>	<u>$1.0 \times DT$</u>	<u>3</u>

Notes:

1. Test methods are found in AASHTO GSSID.
2. Conduct tests at a peak velocity greater than 1-inch/second.
- * Dead Load for the compression capacity test corresponds to the maximum dead load reaction from the lift span during maintenance operations.

51-3.04A(5)(c) Testing Acceptance Criteria

Testing acceptance criteria must meet the AASHTO Guide Specifications for Seismic Isolation Design – 4th Edition (2014).

Prototype test results must comply with the requirements shown in the following table:

Prototype Requirements

Test Methods	Requirement
GSSID 13.2.2.1—thermal PT-A1	Maximum force is less than F_t
GSSID 13.2.2.2—wind and braking preseismic test PT-B1	Maximum force is larger than F_{tr}
GSSID 13.2.2.3—seismic PT-C1	Same as for proof testing
GSSID 13.2.2.3—seismic PT-C2	During the 3 cycles of testing, the minimum K_{eff} must not be less than 80% of the maximum K_{eff} value as measured at the specified cyclic displacement. The minimum EDC must not be less than 70% of the maximum EDC.
GSSID 13.2.2.3—seismic PT-C3	During the 3 cycles of testing, the minimum K_{eff} must not be less than 80% of the maximum K_{eff} value as measured at the specified cyclic displacement. The minimum EDC must not be less than 70% of the maximum EDC.
GSSID 13.2.2.3—seismic PT-C4	During the 3 cycles of testing, the minimum K_{eff} must not be less than 80% of the maximum K_{eff} value as measured at the specified cyclic displacement. The minimum EDC must not be less than 70% of the maximum EDC.
GSSID 13.2.2.3—seismic PT-C5	Under the lateral displacement of DT, the average K_{eff} for 3 cycles must be within 10% of K_{eff}, and the average EDC for 3 cycles must be no less than 85% of EDC.
GSSID 13.2.2.3—seismic PT-C6	During the 3 cycles of testing, the minimum K_{eff} must not be less than 80% of the maximum K_{eff} value as measured at the specified minimum cyclic displacement. The minimum EDC must not be less than 70% of the maximum EDC.
GSSID 13.2.2.4—wind and braking: post-seismic test PT-D1	Maximum force is no less than F_{tr}
GSSID 13.2.2.5—seismic performance verification PT-E1	The average K_{eff} for 3 cycles must be within 10% of K_{eff}, and the average EDC for 3 cycles must be no less than 85% of EDC
GSSID 13.2.2.6—stability PT-F1	The bearing must remain stable with positive incremental stiffness.
GSSID 13.2.2.6—stability PT-F2	The bearing must remain stable with positive incremental stiffness.

[Bearing must remain stable and without any sign of bulging, splits, or fractures after each test.](#)

[For each cycle of the test, include the plotted continuous recording of the load, displacement, time, and hysteretic behavior in the test report.](#)

[Sign reports by the personnel conducting the testing.](#)

[Proof test results must comply with the following requirements:](#)

- [1. At a proof test displacement of DT:](#)
 - [1. For each bearing, the average \$K_{eff}\$ must be within 20 percent of \$K_{eff}\$](#)
 - [2. For all bearings, the average \$K_{eff}\$ must be within 10 percent of \$K_{eff}\$](#)
- [2. The average EDC of each bearing must not be less than 75 percent of EDC](#)

3. The average EDC for both bearings must not be less than 85 percent of EDC
4. The bearing must remain stable and without any sign of bulging, splits, or fractures after each test

For each cycle of the test, include the plotted continuous recording of the load, displacement, time, and hysteretic behavior in the test report.

Sign reports by the personnel conducting the testing.

51-3.04B MATERIALS

51-3.04B(1) General

Provide a bearing system shown in the Caltrans Authorized Materials List for lead core/rubber seismic isolation bearing systems.

Permanently mark all production bearings on two (2) sides with the following information:

1. Bearing number
2. Production lot number
3. Date of fabrication
4. Design dead load
5. Weight of bearing
6. Design bearing displacement
7. Contract number

Provide steel plates in conformance with ASTM A709/A709M, Grade 50.

Provide anchor bolts, nuts, and plate washers in accordance with the plans. Mechanically galvanize anchor bolts and nuts in accordance with ASTM B695. Galvanize washers in accordance with ASTM A123/A123M or ASTM B695.

Provide grout conforming to section 51-1.02G.

The alternate layers of rubber and steel plates vulcanized together must comply with the provisions for laminated elastomeric bearings in ASTM D4014, Grade 3, and the following.

Elastomer Properties

<u>Quality characteristic</u>	<u>Test</u>	<u>Requirement</u>
<u>Tensile strength (min, psi)</u>	<u>ASTM D412</u>	<u>2250</u>
<u>Elongation at break (min, %)</u>	<u>ASTM D412</u>	<u>500</u>
<u>Compression set, 22 hrs at 158 °F (max, %)</u>	<u>ASTM D395, Method B</u>	<u>50</u>
<u>Tear strength (min, lbs/in)</u>	<u>ASTM D624, Die C</u>	<u>180</u>
<u>Ozone resistance (20% strain, 100 hours at 100 ± 2.2 °F)</u>	<u>ASTM D1149 Specimen D518A</u>	<u>No cracks visible with a 7X lens</u>

Elastomer in the rubber portion of the bearing must be natural rubber, type NR.

Provide shim plates made from rolled carbon steel conforming to ASTM A570 Grade 36. A higher grade may be substituted at no additional cost. The nominal thickness for steel laminates must be a minimum of 0.12 inch thick. Do not galvanize steel plates. Cover the steel laminates at the sides of the bearing with a minimum thickness of 0.5 inch of the same elastomer specified for the elastomeric bearing. Ethylene propylene rubber (EPDM) with a minimum thickness of 5/16 inch and ozone resistance equal to the value in the Elastomer Properties table may be used as an elastomer cover.

Stacking of individually laminated pads or cold bending of individual laminated pads will not be permitted.

The lead core must consist of at least 99.9 percent pure lead.

51-3.04B(2) Design Criteria

The isolation bearings must satisfy the performance criteria defined below.

Isolation Bearing Performance Criteria

Seismic Load Parameters									
K_d	K_u	Bridge Longitudinal Direction				Bridge Transverse Direction			
		DT	K_{eff}	EDC	I	DT	K_{eff}	EDC	I
k/in	k/in	in	k/in	$k.in$	s	in	k/in	$k.in$	s
21	209	2.6	169	888	3.05	13.0	51	17098	0.75

Service Load Parameters						
$DL, kips$		LL	F_{tr}	F_t	D_{tr}	D_t
Service	Maint.	kips	kips	kips	in	in
20	1400	435	325	122	6.5	0.3

51-3.04C CONSTRUCTION

Provide isolation bearings conforming to the dimensional clearances and tolerances shown in the plans and described herein.

Installation of the isolation bearings must be compatible with the workspace shown. Determine the required steel plate thickness, subject to the dimensional constraints shown, concrete column height, bearing column reinforcement, and grout pad thickness at each location. Verify all dimensions required for installation of the isolation bearings.

The connecting bolts, rods, and plates shown are considered a minimum requirement. Check the connecting plates, rods, and bolts based on the isolation bearing system proposed for use. Redesign the connecting plates, rods, and bolts if necessary. In addition to varying the plate and grout shown, the bearing height may be varied to accommodate installation.

Protect bearing surfaces from contamination and weather damage prior to installation.

Prepare concrete surfaces in accordance with the plans.

51-3.04D PAYMENT

Payment will be made at the contract unit price for each production isolation bearing. Payment includes all costs associated with the design, shop drawings, proof testing, labor, materials and equipment necessary to furnish and install the isolation bearings as shown on the plans and as specified herein.

The anchor bolts, nuts, washers and grout are included with this work.

The cost of the top and bottom external attachment plates and longitudinal restraints are included in the cost of the bearings.

Furnishing, delivering, and testing prototype bearings is at the Contractor's expense. No additional payment will be made.

Add section 51-9:**51-9 PRECAST CONCRETE BAT HABITAT****51-9.01 GENERAL****51-9.01A Summary**

Section 51-9.01 includes specifications for constructing Precast Concrete Bat Habitats.

Prestressing must comply with section 50.

Reinforcement must comply with section 52.

Cure PC concrete under section 90-4.03.

Precast Concrete Bat Habitats include furnishing the units to the job site ready to incorporate into the work and erecting the members into the final position in the work.

51-9.01B Definitions

Not Used

51-9.01C Submittals

51-9.01C(1) General

Submit an installation work plan for the Precast Concrete Bat Habitats. The work plans must be signed by an engineer who is registered as a civil engineer in the State and include procedures, details and sequences for:

1. Unloading
2. Lifting
3. Installing

Allow 10 days for review.

51-9.01C(2) Shop Drawings

51-9.01C(2)(a) General

Submit shop drawings for the Precast Concrete Bat Habitats.

Shop drawings must include:

1. Construction methods
2. Dimensions
3. Materials
4. Reinforcement

51-9.01D Submittals

51-9.01D(1) General

PC materials must be available for inspection. Allow free access at all times to any portion of the fabrication site where materials are being stored or work is performed.

51-9.01D(2) Acceptance

Precast Concrete Bat Habitats and are inspected at the fabrication site. Notify the Engineer when materials are delivered to the fabrication site. Allow 10 days after notifying the Engineer before starting fabrication.

The Engineer may reject the Precast Concrete Bat Habitats exhibiting any of the following:

1. Excessive cracking
2. Nonrepairable honeycombed or spalled areas
3. Defects affecting performance or structural integrity

51-9.02 MATERIALS

51-9.02A General

Not used

51-9.02B Delivery, Storage, and Handling

Carefully handle, store, transport, and install Precast Concrete Bat Habitats to avoid twisting, racking, or other distortion that would result in cracking or damage.

51-9.03 Construction

The design of the concrete mix, reinforcement, and anchorage for the Precast Concrete Bat Habitats are to be determined by the supplier. The design must ensure that the Precast Concrete Bat Habitats are not damaged during shipping and installation and remain stable in its final condition.

The Precast Concrete Bat Habitats must conform to the details and dimensions shown on the contract plans. Notify the engineer immediately if any revisions to the details or dimensions shown on the contract plans are required due to concerns related to shipping, installation, or stability in the final condition.

51-9.04 Payment

Not Used

Add section 51-10:

51-10 PRECAST CONCRETE TRAFFIC WARNING GATE MONUMENT

51-10.01 GENERAL

51-10.01A Summary

Section 51-10.01 includes specifications for constructing Precast Concrete Traffic Warning Gate Monuments.

Prestressing must comply with section 50.

Reinforcement must comply with section 52.

Cure PC concrete under section 90-4.03.

Precast Concrete Traffic Warning Gate Monuments include furnishing the units to the job site ready to incorporate into the work, installing foundations as necessary, and erecting the members into the final position in the work.

51-10.01B Definitions

Not Used

51-10.01C Submittals

51-10.01C(1) General

Submit an installation work plan for the Precast Concrete Traffic Warning Gate Monuments. The work plans must be signed by an engineer who is registered as a civil engineer in the State and include procedures, details and sequences for:

1. Unloading
2. Lifting
3. Installing

The work plan for the Precast Concrete Traffic Warning Gate Monuments must detail how the installation of the Precast Concrete Warning Gate Monument will interface with the installation of the Traffic Warning Gate.

Allow 10 days for review.

51-10.01C(2) Shop Drawings

51-10.01C(2)(a) General

Submit shop drawings for the Precast Concrete Traffic Warning Gate Monuments.

Shop drawings must include:

1. Construction methods
2. Dimensions
3. Materials
4. Reinforcement

The shop drawings must include details for the foundations and corresponding connections for the Warning Gate Monuments that are located off of the bridge and details for the connections of the Warning Gate Monuments to the bridge deck for the Warning Gate Monuments that are located on the bridge. Provide supporting calculations to ensure that the foundations and connections do not fail when the warning gate monuments are set in their final position. Coordinate the foundation details with the foundation details for the Traffic Warning Gates to ensure that there are no conflicts between the two elements.

51-10.01D Submittals**51-10.01D(1) General**

PC materials must be available for inspection. Allow free access at all times to any portion of the fabrication site where materials are being stored or work is performed.

51-10.01D(2) Acceptance

Precast Traffic Warning Gate Monuments are inspected at the fabrication site. Notify the Engineer when materials are delivered to the fabrication site. Allow 10 days after notifying the Engineer before starting fabrication.

The Engineer may reject the Precast Concrete Traffic Warning Gate Monuments exhibiting any of the following:

1. Excessive cracking
2. Nonrepairable honeycombed or spalled areas
3. Defects affecting performance or structural integrity

51-10.02 MATERIALS**51-10.02A General**

Not used

51-10.02B Metal Components

Structural shapes, structural tubing, plates, bars, bolts, nuts, and washers must comply with section 55-1.02. Other fittings must be commercial quality.

All metal components are subject to AESS category 3 for visible surfaces.

51-10.02C Coatings

Organic zinc-rich primer used to paint the exposed bolt threads must be on the Authorized Material List for organic zinc-rich primers.

Do not chemically treat the galvanized surfaces of the Precast Concrete Traffic Warning Gate Monuments before cleaning and painting. Galvanize the nuts, bolts, and washers after fabrication under section 75-1.02B.

51-10.02D Delivery, Storage, and Handling

Carefully handle, store, and transport and install the Precast Concrete Traffic Warning Gate Monuments to avoid twisting, racking, or other distortion that would result in cracking or damage.

51-10.03 Construction

The design of the concrete mix, reinforcement, foundations, and connections to the bridge deck for the Precast Concrete Traffic Warning Gate Monuments are to be determined by the supplier. The design must ensure that the Precast Concrete Traffic Warning Gate Monuments are not damaged during shipping and installation and remain stable in its final condition.

The Precast Concrete Traffic Warning Gate Monuments must conform to the details and dimensions shown on the contract plans and the digital files provided. Notify the Engineer immediately if there is a conflict between the plans and digital files and if any revisions to the details or dimensions are required due to concerns related to shipping, installation, or stability in the final condition.

The concrete surface finish for the Precast Concrete Traffic Warning Gate Monuments must comply with 51-1.03F(3) Class 1 Surface Finish.

Prepare and paint the galvanized surfaces of the Precast Concrete Traffic Warning Gate Monuments under section 59-3.

51-10.04 Payment

Not Used

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52 REINFORCEMENT

Add between the 1st and 2nd paragraphs of section 52-1.02B:

Where Grade 80 reinforcement is shown, reinforcing bars must be deformed bars complying with ASTM A706/A706M, Grade 80, including S1 supplementary requirements.

Grade 80 reinforcement must have a minimum ultimate tensile strain of 0.095 and a minimum ultimate tensile strength of 98 ksi.

Replace section 52-4 with:

52-4 ELECTRIC-RESISTANCE WELDED STIRRUPS FOR CONCRETE BARRIER REINFORCEMENT CAGES

52-4.01 GENERAL

52-4.01A Summary

Section 52-4 includes specifications for welding longitudinal support wire to stirrups using electric-resistance welding (ERW) to partially fabricate reinforcing cages for concrete barriers.

Electric-resistance welded supports may be used only for concrete barrier stirrups on structures with uncoated reinforcement.

You may use ERW to weld support wire to no.5 reinforcing bars or smaller. The support wire must be W 6.5 or smaller.

52-4.01B Definitions

partially fabricated reinforcing cage: Stirrups for concrete barrier reinforcing cages held in position by welded longitudinal support wires.

lot: 150 count, or fraction thereof, of welds for each size of reinforcing bar and support wire and for each change to the welding equipment settings.

52-4.01C Submittals

52-4.01C(1) General

Not Used

52-4.01C(2) Certificate of Compliance

Submit a certificate of compliance for each shipment of partially fabricated cages. Include with the submittal:

1. Identification of each cage including lot numbers, welds traceable by welding clamp, and location tracking information.
2. Grade and size of welded reinforcement used for the stirrups and support wire.
3. For the reinforcing bar and support wire:
 - 3.1. Heat number
 - 3.2. Mill certificate

52-4.01C(3) Test Samples

Submit QA test samples to METS.

Include copies of certificates of compliance with the test samples.

52-4.01C(4) Welding Quality Control Plan

Submit 2 copies of a welding QC plan for each subcontractor or supplier performing ERW. The QC plan must include:

1. WPSs
2. Names and certifications of welding personnel, including qualifications for the QC Manager
3. Welding procedures including current setting, welding clamp force, weld time, and hold time for each size of reinforcement to be welded
4. Welding equipment manufacturer's operating instructions including the recommended calibration frequency of the welding equipment
5. Documentation of ERW equipment calibration
6. Fabricator's *QC Process Control Manual*
7. Method for identifying welds and tracking lots

For the contents, format, and organization required for a welding QC plan, go to the METS website.

52-4.01C(5) Shop Drawings

Submit shop drawings showing the stirrup positioning, welded connections of the support wire to the stirrups, and welding equipment layout. Allow 15 days for the Engineer's review.

52-4.01C(6) Prefabrication Test Results

Submit the prefabrication test results within 3 business days of prefabrication testing. The prefabrication test results must include:

1. Contract number
2. Bridge number
3. Welds identified by welding clamp
4. Reinforcement and support wire sizes
5. Test specimen length
6. Physical condition of test samples
7. Notable defects
8. Ultimate tensile strength of each sample
9. Location of necking area of each sample

Allow 3 business days for the Engineer's review.

52-4.01C(7) Quality Control Test Reports

Submit a QC test report within 7 days of testing for each lot. The report must be prepared by the authorized laboratory performing the testing. The report must be signed by the QC manager. For each lot, the report must include:

1. Contract number
2. Bridge number
3. Lot numbers with welds identified by welding clamp
4. Installed location of completed cages
5. Reinforcement and support wire sizes
6. Cage types
7. Cage lengths
8. Test specimen length
9. Physical condition of test samples
10. Notable defects
11. Ultimate tensile strength of each sample
12. Location of necking area of each test sample

Allow 3 business days for the Engineer's review.

52-4.01D Quality Assurance**52-4.01D(1) General**

Provide a welding QC manager. The QC manager must be registered as a civil engineer in the State or currently certified as a CWI.

52-4.01D(2) Prewelding Meeting

Before submitting a welding QC plan, hold a prewelding meeting to discuss the work and the requirements for the welding QC plan. The meeting attendees must include the Engineer, your welding QC manager, and a representative from each entity performing welding or welding inspection.

52-4.01D(3) Test Samples

Samples must be a minimum length of 4 feet of bar reinforcing steel with a support wire welded at midpoint. You may furnish shorter length samples if authorized.

Prepare the samples using the same materials, procedures, equipment, and equipment settings used in the work.

The welding clamps that produce the samples are determined by the Engineer.

Prepare QC test samples and the Department acceptance test samples concurrently:

1. During fabrication of samples representing the 1st lot
2. From 1 of every 5 subsequent lots, or fraction thereof, randomly selected by the Engineer

After receiving notification that lots are ready for QC testing, the Engineer (1) randomly selects test samples to represent each lot and (2) places tamper-proof markings or seals on the test samples.

Before transporting test samples to an authorized laboratory and METS:

1. Securely bundle and package the test samples for each test in a way that preserves their condition during transportation
2. Identify each test sample by lot number and Contract number using weatherproof markings
3. Attach a completed Sample Identification Card to each bundle

If a sample show signs of tampering before testing, the sample is rejected.

52-4.01D(4) Quality Control**52-4.01D(4)(a) General**

Test the samples for tensile strength under California Test 670, Section E, Part III, Tensile Test.

Tensile testing must be performed by an authorized laboratory. The laboratory must be on the Authorized Laboratories List for testing reinforcing steel splices.

52-4.01D(4)(b) Prefabrication Testing

Before the start of fabrication of production cages, prepare 4 samples from each welding clamp.

Notify the Engineer at least 5 business days before fabricating the samples.

If 3 or more of the 4 samples from each welding clamp attain the specified minimum tensile strength, the Department accepts the prefabrication test results.

If 2 of the 4 samples attain the specified minimum tensile strength, determine the cause of the failure and take corrective action as specified in section 52-4.01D(4)(c). Fabricate 4 additional samples from the clamp that produced the noncompliant samples and perform tensile tests until at least 3 of the 4 samples attain the specified minimum tensile strength.

Do not start fabrication of production cages until the Department accepts the test results.

52-4.01D(4)(c) Fabrication Testing

During fabrication of production cages, for each lot prepare 8 test samples.

At least 5 business days before performing fabrication testing, notify the Engineer of:

1. Date of the testing
2. Location of the authorized laboratory where the tests will be conducted
3. Number of lots to be tested

Do not perform tests on test samples from bundles containing fewer than 8 samples. Test 4 of the samples. The Engineer determines the samples to be tested.

If 3 or more of the 4 samples from a lot attain the specified minimum tensile strength, the Department accepts the lot.

If 2 of the 4 samples from a lot attain the specified minimum tensile strength, perform additional tests on the remaining samples. If any of the additional samples do not attain the specified minimum tensile strength, the Department rejects the lot.

If a lot is rejected, stop production until the following corrective actions have been performed:

1. QC manager reviews your QC process
2. You have prepared a welding rejection mitigation report describing:
 - 2.1. Cause of the failure
 - 2.2. Method used to identify the cause of failure
 - 2.3. Identification of affected lots
 - 2.4. Provisions for preventing similar failures in future lots
 - 2.5. Procedure for repairing or replacing the welded connections in the rejected lot
3. Engineer has notified you that the welding rejection mitigation report is authorized

52-4.01D(5) Department Acceptance

The Department accepts lots based on your QC tension test results specified in section 52-4.01D(4)(c).

The Department performs tensile test on samples from the 1st lot and from 1 of every 5 subsequent lots, or fraction thereof, randomly selected by the Engineer.

If 3 or more of the 4 samples attain the specified minimum tensile strength, the Department accepts the lot.

If 2 of the 4 samples attain the specified minimum tensile strength, fabricate 4 additional samples using the same materials and welding machine settings as the noncompliant lot. If any of the 4 additional samples do not attain the minimum specified tensile strength, the Department rejects the lot.

If QC and Department acceptance testing results have different compliance determinations, the Department will perform QA testing for all subsequent lots until QC testing and the Department testing are consistent for 2 consecutive lots before resuming testing for 1 of every 5 lots, or fraction thereof, as determined by the Engineer.

52-4.02 MATERIALS

52-4.02A General

Reinforcing bars must comply with ASTM A706, Grade 60.

Support wire must comply with the specifications for plain wire in ASTM A1064.

The tensile strength of reinforcing bars with the support wire welded to the bar must be at least 80,000 psi.

52-4.02B Fabrication

Perform ERW at a fabrication shop using computer-controlled equipment.

Weld the support wire to the stirrups. The stirrups must be positioned as shown. The support wire must be capable of maintaining the dimensions, position, and shape of the stirrups until the cage is complete.

52-4.03 CONSTRUCTION

Provide bracing to avoid collapse of the cage during assembly, transportation, and placement as needed.

Field tack welding of support wire to reinforcement is not allowed.

Wiring longitudinal reinforcement at each stirrup intersection is not required.

52-4.04 PAYMENT

Not Used

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55 STEEL STRUCTURES

Add to section 55-1.01C:

55-1.01C(5) Lift Span Erection Plan

Submit a detailed Erection Plan for all phases, stages, and conditions anticipated during lift span erection, including float-in. Include all aspects of erection and sequences and detail all aspects of the work.

At a minimum, include the following in the Erection Plan:

1. Detailed sequence of construction, including:
 1. Methods for setting lift span bearings
 2. Methods for construction surveying and monitoring
 1. Methods for measuring the loads in the arch rib temporary supports
 2. Complete listing of all proposed sensors and data collection equipment, schematic drawings, installation procedures, and protection plans.
 3. Acceptance range for measured versus design forces and the course of action if measured forces are not within the acceptance range.
 3. Methods for geometry correction procedures
 4. Methods for float-in
2. Calculations for strength, stability, and geometric requirements, considering wind, temperature variations, and other relevant loads.
3. Detailed shop drawings and calculations for temporary supports and bracing
4. Product literature for all equipment
5. Detailed shop drawings showing locations of lifting points
6. Evidence of the Contractor's AISC Certification
7. Documentation demonstrating experience with similar sensors

Ensure all calculations and shop drawings are based on the design specifications and criteria stated in the contract documents.

Provide calculations and drawings for each stage of erection that are signed and sealed by a registered Professional Engineer in the State.

55-1.01C(6) Lift Span Monitoring Reports

Submit Monitoring Reports for the lift span as described in section 55-1.03C(4)(b) to the Engineer for review and approval.

55-1.01C(7) Lift Span Shop Preassembly Plan

Submit a proposed method of lift span shop preassembly for review and approval by the Engineer.

At a minimum, include the following:

1. Sequence of shop preassembly
2. Means of measurement and details on how the effects of temperature on the geometry of the shop preassembly will be accounted for
3. Definition of workpoints for control of geometry.

Add to section 55-1.01D:**55-1.01D(5) Contractor Qualifications**

For the lift span, employ an Erection Contractor certified as a Certified Steel Erector (CSE) with a Bridge Endorsement (BEE) by the AISC Certification Program.

Ensure the Superintendent in charge of sensor installation for lift span erection monitoring has at least four years of experience with similar sensors.

Add to section 55-1.02D:**55-1.02D(8) Anti-Slip Coating**

Furnish an anti-slip coating in accordance with section 59-2.

Add to section 55-1.02E(1):

Perform fabrication of arch ribs in accordance with the Standard Specifications, these Special Provisions, and the AASHTO LRFD Steel Bridge Fabrication Specifications. In the event of conflict, the more stringent applies.

Add to section 55-1.02E:**55-1.02E(10) Shop Preassembly for the Lift Span**

Assume responsibility for attaining accurate geometry of the lift span.

Drill out field connections in shop preassembly.

Do not commence shop preassembly without approval of the Lift Span Shop Preassembly Plan by the Engineer.

For arch rib preassembly, assemble at least two contiguous segments accurately adjusted for line and camber. Successive assemblies shall consist of at least one segment of the previous assembly, with that segment kept in the same position as during the previous assembly, plus one or more segments added to the advancing end.

Perform shop preassembly to ensure deviations do not accumulate.

Use working points on arch rib segments and upper lateral bracing shown on the plans such that geometry of the members can be adequately controlled and target geometry can be achieved. Working points may be added or modified with the Engineer's approval.

Provide markings indicating the alignment of splice plates and members during shop preassembly such that the angular alignment of the splice can be readily determined when bolted up in the field.

55-1.02E(10)(a) Tolerances**55-1.02E(10)(a)(i) Arch Ribs**

Tolerance on position of working points is +/- 1/4" with the supplemental requirements on length noted below.

The tolerance on length along the arch ribs between upper lateral bracing locations is +/- 1/8".

55-1.02E(10)(a)(ii) Upper Lateral Bracing

Tolerance on upper lateral bracing length is +/- 1/4".

Replace section 55-1.03C(4) with:**55-1.03C(4) Special Erection Requirements for the Lift Span****55-1.03C(4)(a) General**

Assume responsibility for the stability of all elements of the partially erected lift span structure under all loading during all stages of erection. This includes the stability of the lift span, falsework, and other components subjected to loads during erection.

Assume responsibility for any special permits or measures required to accommodate the proposed erection methods.

The Suggested Lift Span Staging shown in the plans is for informational purposes only and is one method to erect and float-in the lift span. If this method is utilized, verify the method for accuracy and applicability.

Do not fabricate lift span structural steel until Erection Plan is approved.

Provide necessary measures to mitigate wind loads during construction, especially for freestanding arches and partially erected structures. Supply appropriate bracing and support to resist construction wind loads at all stages.

Movements imposed on lift span bearings during construction must not exceed those for which the bearings have been designed.

55-1.03C(4)(b) Construction Survey and Monitoring

Perform a construction survey of erected lift span members after each significant erection step (e.g., after each pair of arch rib segments) and prior to commencing the next erection step.

Provide additional surveys as required to control the work and as directed by the Engineer.

At a minimum, check the alignment and elevation of each end of the erected arch rib. Record elevations on both sides of the structure at each location surveyed.

Monitor forces in temporary supports used for the erection of the arches.

Store all sensors and data acquisition equipment in a climate-controlled facility prior to installation and protect all exposed wiring. Demonstrate to the Engineer that installed sensors are in proper working order and functioning. Repair or replace any defective sensors after installation.

Download data from the sensors during each erection stage, preferably at night to minimize temperature effects.

Maintain a log of construction survey and load measurements for the erection, including all adjustments required to correct alignments and elevations, and include this log in each Monitoring Report. Record the time, temperature, and location of all construction loads for each entry.

Compare collected data to structural calculations at each erection stage and include this comparison in the Monitoring Report. Provide Monitoring Reports at each stage of erection that are signed and sealed by a registered Professional Engineer in the State. Do not commence next stage of erection until Monitoring Report has been approved by the Engineer.

55-1.03C(4)(c) Geometry and Tolerances

Ensure proper running clearances are provided for all parts as the lift span is guided along its lift travel.

Ensure the geometry of the finished structure under full dead load at a temperature of 68 deg. F is within the following tolerances:

1. Lift Span Length (measured between X and X): +1/8", -1/2"
2. Lift Span Width (measured between X and X): +X", -X"

Deviations from the specified tolerances will not be accepted.

Use auxiliary bracing or cables with turnbuckles as needed for geometric control prior to final bolting.

Accurately install and adjust all span guide rollers and set all bridge bearings as specified.

Do not substitute members or connections with lesser dimensions or properties than those shown on the plans.

55-1.03C(4)(d) Jacking Devices

Assume responsibility for the strength and operation of all jacking and adjusting devices used.

Use hydraulic-type jacking devices connected to a common supply meeting the following:

1. Load capacity of at least 100 percent more than the load to be lifted.
2. Stroke to complete the lift in one operation.

Design and detail any jacking or adjusting procedure so that the load in the members being jacked can be transferred to safety shims or blocking. Ensure that these supports closely follow any required adjustment or

lifting movement, allowing the loads to be carried independently of the jacks or adjusting devices in case of failure. Permit the removal of the jacks or adjusting devices at any stage of the operation for renewal, repair, or maintenance.

Remove all jacks or adjusting devices and place full dead load of the structure on the lift span bearings before approval by the Engineer for operation of the bridge. Do not operate the bridge until approved by the Engineer.

55-1.03C(4)(e) Lift Span Float-In

The lift span must be erected in its entirety prior to the float-in. All members must be installed, bolted, and painting completed.

Coordinate proposed closure times for float-in with all interested agencies. Provide a preliminary warning notice to these agencies one month prior to the proposed float-in date. Submit copies of notification letters to the Engineer. Send the final notice to these agencies one week prior to the proposed float-in date. Do not send the final notice until the Engineer has given written approval and after the Engineer has reviewed the condition of the lift span, towers, operating ropes, machinery, and electrical control system.

Only a serious inclement weather event or an unforeseen structural problem may delay the final proposed float-in schedule. A written delay approval from the Engineer must be obtained for a delay. Send emergency notifications to all interested agencies.

After the float-in has been completed, send a written letter to the Engineer and interested agencies informing them of the completion of the float-in.

Add to section 55-1.02E(1):

Apply the anti-slip coating to the hanger floor support beams under section 59-2.

Replace section 55-2 with:

55-2 HANGER ASSEMBLIES

55-2.01 GENERAL

55-2.01A Summary

Section 55-2 includes furnishing, fabricating, testing, and installing the hanger assemblies.

55-2.01B Definitions

hanger assembly: One structural strand, one open strand socket, one type 7 socket, one pin, one cotter pin, and two nylon washers.

55-2.01C Submittals

Submit the following certifications:

1. Manufacture of strand to this specification
2. Tensile strength of strand
3. Modulus of elasticity of strand
4. Actual breaking strength
5. Prestretching, measuring, and proof loading
6. Material certification of sockets, pins, and washers

Submit working drawings for all hanger assemblies prior to commencing work.

55-2.01D Quality Assurance

55-2.01D(1) Structural Strand

Perform tests for modulus of elasticity and breaking strength for each manufactured length of strand in accordance with ASTM A586. Provide a specimen gauge length of 100 inches. Attach the anchor socket to each end of the strand and load the strand through the sockets. Use identical socketing procedures for the test specimen and assemblies shipped to site. If the test specimen fails to meet the minimum breaking strength requirement, cut another test sample from the same manufactured length and test. If it also fails, the

manufactured length of strand may be rejected by the Engineer. If rejected, furnish new strand length that is subject to the same testing and approval procedures outlined herein. No compensation will be made for the cost of the rejected strand, including testing costs.

Cut specimens from both ends of each single length or coil of zinc-coated wire to use for the breaking strength tests. The Engineer will witness as many of these tests as desired. When requested by the Engineer, perform a test for tensile strength in conformance with the requirements of ASTM A586 of any coils selected at random by the Engineer. For making these tensile tests, the Engineer will preferably select the coils from among those which have not been tested in the Engineer's presence.

55-2.01D(2) Anchor Sockets

Proof load each socket to be installed as part of the structure to 55% of the breaking strength of the attached structural strand following attachment of the structural strand.

Subject each socket type to radiographic inspection in accordance with the following frequency: first, eighth, eighteenth, thirty-eighth, sixty-eighth, and one hundred and eighth socket. Submit radiographic shot schedule of castings to the Engineer for review and approval for each socket type. Perform radiographic inspection in accordance with ASTM E94/E94M - Standard Guide for Radiographic Examination Using Industrial Radiographic Film and ASTM E446 - Standard Reference Radiographs for Steel Castings up to 2 inches in Thickness. Notify the Engineer at least five (5) working days prior to scheduled radiographic inspections for witness coordination.

Perform radiographic inspections and provide certification to the Engineer for review and approval. Perform inspections by approved American Society for Nondestructive Testing ASNT-TC-1A examiners.

Fully inspect all sockets by the magnetic particle method conforming to the requirements of ASTM E709 and acceptance standard ASTM E125.

Charpy V-notch impact test the anchor sockets in accordance with ASTM A781/A781M, Supplemental Requirement S9. Perform the testing at the same frequency as for the radiographic testing. The samples must withstand an impact of 25 ft-lbf at 40°F.

Perform tests for galvanizing (weight and adherence) on samples of not less than 5% of the coils of any lot of wire. The percentage of coils tested for galvanizing may be increased at the request of the Engineer. If tests of any of these coils fail to meet the requirements, then perform tests on all the coils in the lot. Unless at least 80% of the coils pass the test, the entire lot will be rejected. Any coil failing to meet requirements will be rejected.

55-2.01D(3) Pins

Charpy V-notch impact test the pins in accordance with ASTM A673/A673M, P frequency. The samples must withstand an impact of 25 ft-lbf at 40°F.

Perform ultrasonic testing at the same frequency as for the radiographic testing of the anchor sockets.

55-2.02 MATERIALS

55-2.02A Structural Strand

Provide structural strand conforming to ASTM A586 Class A coating inner wires, Class C coating outer wires. Prestretch all strands to 55% of the breaking strength in accordance with ASTM A586. Any kinked or damaged strands will be rejected. Straightening of bent wires will not be permitted.

Socket the structural strand in the anchor sockets using zinc conforming to prime western grade or higher purity zinc as defined by ASTM B6. Preheat the basket of the sockets to expel moisture and to prevent the molten zinc from congealing before it has completely filled the narrow lower end of the basket. Strands will be rejected if the socketing procedure results in bare wires within the sockets.

Measure and mark the structural strand under well-defined uniform temperature conditions, under cover, or at night, and while the strand is held under dead load tension.

Upon fabrication of the complete hanger assembly, position the bottom of the spanner nut midway in available travel on the Type 7 socket. Measure the final length of each socketed hanger strand as the distance between the bottom of the spanner nut in the Type 7 socket and the centerline of the pin in the open strand socket.

Record this length to within 0.001 of a foot at a measuring tension equivalent to the dead load tension as shown on the plans. The actual length, as measured above, must not vary more than +/- 1/2 inches from the designed/calculated length shown in the plans (including any temperature adjustment). Calculate and record the deviation between the design/calculated length and actual length for each hanger assembly. Stamp this deviation onto each respective Type 7 socket of the completed hanger assembly.

Any deviation over the specified limits of +/- 1/2 inches will be rejected and replaced with a new hanger assembly.

At the time the structural strands are measured, place a permanent paint stripe on the top surface along the full length of the strand which will be referenced to eliminate any change in length of the hanger strand due to twisting.

Preassemble all hanger assemblies and deliver to the site as complete units. Package the hanger assemblies on reels with a minimum diameter of 5 feet.

After the structural strand is prestretched, do not pull it into a curve that is smaller than 5 feet.

55-2.02B Anchor Sockets

Provide anchor sockets labeled in the plans as open strand socket and Type 7 socket that conform to the requirements of ASTM A148/A148M and Federal Specification RR-S-550F, unless modified herein. Type 7 sockets must have internal threads to accommodate jacking.

Galvanize the anchor sockets in accordance with ASTM A123/A123M.

Provide all anchor sockets and socketed zinc connections that are at least Grade 105/85 and meet or exceed 110% of the breaking strength of the designated structural strand attached. Large sand spots, inclusions, and blow holes, as determined by the Engineer, will be cause for rejection of the casting.

Defects exceeding the severity levels shown in the table "Permissible Severity Level of Defects" will be cause for rejection of a socket.

Permissible Severity Level of Defects

<u>Category</u>	<u>Defect</u>	<u>Severity Level Permitted</u>
<u>A</u>	<u>Gas Porosity</u>	<u>3</u>
<u>B</u>	<u>Sand Slag Inclusions</u>	<u>3</u>
<u>C</u>	<u>Shrinkage:</u>	
	<u>Type 1</u>	<u>3</u>
	<u>Type 2</u>	<u>3</u>
	<u>Type 3</u>	<u>3</u>
	<u>Type 4</u>	<u>3</u>
<u>D</u>	<u>Crack</u>	<u>Not Permitted</u>
<u>E</u>	<u>Hot Tear</u>	<u>Not Permitted</u>
<u>F</u>	<u>Insert</u>	<u>Not Permitted</u>
<u>G</u>	<u>Mottling</u>	<u>Not Permitted</u>

If a socket is rejected, radiographically inspect all other sockets from the same heat at no additional expense.

Rejected castings may be repaired with Engineer's approval. Submit proposed repair procedures. If approved by the Engineer, perform repairs at no additional expense. Minor defects may be removed by grinding or chipping without welding repair, provided the following requirements are complied with:

1. The depth of the defect does not exceed 3% of the specified dimension.
2. The removal of metal does not appreciably affect the strength of the casting, as determined by the Engineer.
3. The remaining wall thickness is equal to or greater than the required minimum wall thickness.
4. The surrounding metal is ground to a smooth contour with the elimination of apparent stress risers.

Defects exceeding those defined above may be repaired by welding if approved by the Engineer. Submit all proposed repair procedures to the Engineer in writing and include a description of the defect, the size and shape of the excavation, the welding specification, and the amount of preheat and post heat to be utilized.

Line bore pin holes for open strand sockets in accordance with section 55-1.02E(5). The pin hole diameter must not exceed that of the pin by more than 0.0625" as measured on the galvanized surfaces. The galvanizing thickness must not exceed 0.03125" on the inside surface of the pin hole where it contacts the pin.

Pin holes not meeting these requirements will be rejected. Replace anchor sockets at no additional expense.

55-2.02C Pins

Provide pins connecting the open strand sockets to the anchor plate that conform to the requirements of ASTM A668/A668M, Class H. Supplemental Requirements S6 and S7 apply.

Fabricate pins in accordance with section 55-1.02E. Galvanize the pins in accordance with ASTM A123/A123M. The galvanizing thickness must not exceed 0.03125" on the pin.

Pins not meeting these requirements may be rejected at the Engineer's discretion. Replace pins at no additional expense.

55-2.02D Cotter Pins

Provide cotter pins that are stainless steel Type 316.

55-2.02E Nylon Washers

Provide nylon washers that are glass-reinforced nylon resin or other approved material, with a minimum of 33% glass loading, a minimum elastic modulus of 1,000,000 psi, and a minimum tensile strength of 20,000 psi.

55-2.02F EPDM Rubber Sheet

Provide EPDM rubber sheets with a Shore A hardness of 60 ± 5 that conforms to ASTM D2000 classification M2AA or better with a minimum tensile strength of 1500 psi and elongation of 300%.

55-2.02G Hanger Clamp

XX

55-2.02H Hanger Spacer

Fabricate hanger spacers from ASTM A709/A709M Grade 50W steel with ASTM F1554 Gr. 55 threaded rod, ASTM A53/A53M Gr. B pipe, ASTM F436/F436M washers, ASTM A563/A563M nuts, and ASTM A193/A193M U-bolts.

55-2.03 CONSTRUCTION

Store the hanger assemblies in a clean, dry area.

Install the hangers without twist.

Adjust the distance between the bottom of the spanner nut of the Type 7 socket and the centerline of the pin in the open strand socket by moving the bottom of the spanner nut a distance equal to the deviation stamped on the Type 7 anchor socket from its location at midway in available travel.

55-2.04 PAYMENT

Payment will be made at the lump sum price bid. Payment includes full compensation for labor, materials, tools, equipment, labor, and incidentals necessary to furnish, fabricate, test, and install the hanger assemblies as shown on the plans and as specified herein.

All components, including structural strand, anchor sockets, pins, cotter pins, nylon washers, hanger clamps, hanger spacers, EPDM rubber sheets, and required testing are included.

Replace section 55-3 with:
55-3 KNUCKLE COVER

55-3.01 GENERAL

55-3.01A Summary

Section 55-3 includes designing, furnishing, fabricating, and installing the knuckle covers.

Knuckle covers are the fiber-reinforced polymer (FRP) aesthetic coverings over the structural steel at joints L0 and L12 of the lift span.

55-3.01B Definitions

Not Used

55-3.01C Submittals

Submit the following product data:

1. List of part numbers, where applicable.
2. Manufacturer's product data with installation and maintenance instructions.
3. Manufacturer's instructions and recommendations for product delivery, storage, and handling.
4. Manufacturer's warranty.

Submit structural design calculations and shop drawings of knuckle cover signed and sealed by a Professional Engineer registered in the State. Include the following:

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents.
2. Include list of applicable building codes, design loads, and other factors applied.
3. Indicate reaction forces related to connections.
4. Provide structural design and locations of connections for knuckle cover. Provide engineering design as required to achieve knuckle cover indicated in the plans and specifications.

Submit shop drawings of the knuckle covers, including dimensions, adjacent construction, materials, thicknesses, fabrication details, required clearances, field jointing, tolerances, colors, finishes, methods of support, integration of components, and anchorages. Show details of hinges, support system for holding the knuckle cover hinged portion in the open position, and method for locking the knuckle cover hinged portion in the closed position.

Submit a minimum 12-inch by 12-inch sample in color, texture, and finish to the Engineer for approval.

Submit manufacturer's qualifications as described herein.

55-3.01D Quality Assurance

55-3.01D(1) General

Inspect each molded piece to ensure compliance with specified requirements, including nominal dimensions.

55-3.01D(2) Manufacturer's Qualifications

Provide products manufactured by a firm specializing in the manufacture of fiberglass fabrications, with a minimum of five years of experience.

55-3.01D(3) Warranty

Warrant fabrications to be free from defects due to materials and workmanship for ten (10) years.

55-3.01D(4) Preconstruction Meeting

Prior to commencing fabrication of the knuckle covers, hold a preconstruction meeting with the Engineer, the Contractor, and a representative from the fiberglass manufacturer.

Be prepared to discuss delivery, storage, installation, and coordination of scheduling with other work.

55-3.01D(5) Mock-Up

Provide a mock-up of the knuckle cover to the Engineer for review and approval prior to fabricating production knuckle covers.

Mock-up may be at a reduced size with prior approval from the Engineer.

55-3.02 MATERIALS**55-3.02A General Design Criteria**

Design knuckle cover and fastening systems for the following:

1. _____ mph winds
2. _____ pounds per square inch live load with deflection limited to [1/360][1/240] of span.
3. _____ pounds per square inch dead load with deflection limited to [1/360][1/240] of span.
4. _____ psf snow load.
5. Meet requirements of applicable building codes.

Installed products must be capable of withstanding positive and negative wind pressure without structural failure, cracking, crazing, permanent distortion, or displacement.

Design knuckle covers to be hinged at the locations shown in the plans for maintenance and inspection of the underlying structural steel. Locate hinges to be concealed when the knuckle cover hinged portion is in the closed position. Provide a method of locking the knuckle cover hinged portion in the closed position. Locate the locks so they are not exposed to the weather.

Design and provide a support system that enables the knuckle cover hinged portion to be fixed in the open position for maintenance and inspection. Design this support system for the loads provided herein.

Design the top surface of the knuckle cover to accommodate architectural light mounting as shown in the plans.

Edges must be smooth and free of sharp projections.

Reinforce all penetrations or cutouts to maintain structural integrity.

Provide waterproofing and/or drainage provisions to ensure water doesn't collect within the knuckle covers.

The weight of each knuckle cover, including anchors and fasteners, must not exceed XXX lbs.

55-3.02B Delivery, Storage, and Handling

Handle, store, and transport knuckle covers according to manufacturer's recommendations and in a manner that prevents damage.

Protect knuckle covers from damage by retaining shipping protection in place until installation.

Except for damage caused by others, the installer is responsible for chipping, cracking, or other damage to knuckle covers, after delivery to the job site and until installation is completed, inspected, and approved by the Engineer.

55-3.02C Fiber-Reinforced Polymer (FRP)**55-3.02C(1) Material Characteristics**

Provide a molded exterior surface that is ultraviolet (UV) inhibited, NPG-ISO polyester gel coat, 18 to 22 mils thick.

Provide back up laminate meeting the following requirements:

1. Resin: Isophthalic polyester resin meeting ASTM E84, Class 1 (flame spread rating of 25 or less)
2. Fiberglass Reinforcement: "E" type fiberglass with random chopped fibers. Glass content approximately 25% to 30%, except 15% for filled resin systems
3. Laminate Thickness: Nominal thickness of 3/16". Additional thickness, reinforcement, and sandwich structures as needed for structural integrity.

55-3.02C(2) Mechanical Properties

<u>Property</u>	<u>Value</u>	<u>Test method</u>
<u>Tensile strength</u>	<u>72,000 psi</u>	<u>ASTM D638</u>
<u>Flexural strength</u>	<u>20,000 psi</u>	<u>ASTM D790</u>
<u>Flexural modulus</u>	<u>0.9 x 10⁶ psi</u>	<u>ASTM D790</u>
<u>Compressive strength</u>	<u>17,000 psi</u>	<u>ASTM D695</u>
<u>Bearing strength</u>	<u>9,000 psi</u>	<u>ASTM D638</u>
<u>Thermal expansion</u>	<u>10 x 10⁻⁶ °F</u>	<u>--</u>
<u>Specific gravity</u>	<u>1.5</u>	<u>--</u>

Specialty resins not meeting the above requirements may be permitted at increased thicknesses with approval from the Engineer.

55-3.02C(3) Finish

Type: Factory-applied gel coat.

Color: White to match bridge paint color.

Gloss: Semi-gloss.

Surface Texture: Aluminum oxide.

55-3.02C(4) Tolerances

<u>Characteristic</u>	<u>Tolerance</u>
<u>Part thickness</u>	<u>± 1/16 inch</u>
<u>Gel coat thickness</u>	<u>± 2.5 mils</u>
<u>Length</u>	<u>± 1/8 inch</u>
<u>Variation from square</u>	<u>1/8 inch</u>
<u>Hardware location variation</u>	<u>± 1/4 inch</u>

55-3.02C(5) Identification

Identify each part with a unique serial number using permanent ink.

Number parts to coordinate with the shop drawings.

55-3.02C(6) Curing and Cleaning

Cure and clean knuckle covers prior to shipment to remove material which may be toxic to plant or animal life and/or incompatible with adjacent building materials.

55-3.02D Joint Sealant

Provide a flexible polyurethane or silicone joint sealant that is compatible with fiberglass and substrate materials.

55-3.02E Anchors and Fasteners

Provide anchors, fasteners, and other accessories required for proper installation of knuckle covers as recommended by the manufacturer.

55-3.03F Hinges

Provide hinges that are Type 316 stainless steel.

55-3.03G Locks

Provide keyed locks that are rated for severe weather exposure.

Key all locks with the same master key. Provide six (6) keys to the Engineer.

55-3.03 CONSTRUCTION**55-3.03A Pre-Installation Examination**

Observe field conditions and verify that substrates are ready for installation of knuckle covers.

Verify field dimensions that affect the installation of knuckle covers.

Verify that bearing surfaces are true and level.

Verify that support framing has been constructed to allow accurate placement, alignment, and connection of knuckle covers to structure.

Report discrepancies between design dimensions and field dimensions, which could adversely affect installation, to the Engineer.

Do not proceed with installation until discrepancies are corrected, or until installation requirements are modified and approved by the Engineer.

Beginning installation means acceptance of existing conditions.

55-3.03B Installation

Install knuckle covers in accordance with manufacturer's instructions and approved shop drawings.

Seal edges of non-removable joints with joint sealant.

55-3.03C Protection

Comply with manufacturer's recommendations and instructions for protecting knuckle covers during construction activities.

55-3.03D Cleaning

After installation, clean installed knuckle covers using cleaning methods and materials approved by the manufacturer.

55-3.04 PAYMENT

Payment will be made at the contract unit price per each knuckle cover. Payment includes full compensation for all design, labor, materials, tools, equipment, labor, and incidentals necessary to design, furnish, and install the knuckle covers as shown on the plans and as specified herein.

Replace section 55-4 with:

55-4 ACCESS SYSTEM**55-4.01 GENERAL****55-4.01A Summary**

Section 55-4 includes furnishing, fabricating, and installing the tower and pier access systems.

The access system consists of stairways, walkways, landings, ladders, access hatches, safety gates, handrails, doors, and supporting steel for accessing areas of the tower, piers, and rooms within the piers. The removable platform within the pier is included with the access system.

Steel grating and FRP grating are not included.

55-4.01B Definitions

Not Used

55-4.01C Submittals

Comply with section 55-1.01C and as modified herein.

Submit manufacturer's product data for all manufactured products described herein.

Submit copies of manufacturer's warranties described herein.

Submit the following for the removable platform and supporting framework:

1. Design calculations signed and sealed by a Professional Engineer licensed in the State.
2. Detailed shop drawings

55-4.01D Quality Assurance

55-4.01D(1) General

Comply with section 55-1.01D and as modified herein.

55-4.01D(2) Access Hatches

Utilize a manufacturer with a minimum of five years manufacturing similar products.

Utilize a manufacturer registered to ISO 9001 Quality Standards.

Provide a warranty that materials are free of defects in materials and workmanship for a period of five years from the date of purchase. If a part fails to function in normal use within this period, manufacturer must furnish a new part at no charge.

55-4.01D(3) Doors

Provide a warranty that doors, frames, and hardware are free of defects in materials and workmanship for a period of five years from the date of purchase. If a part fails to function in normal use within this period, manufacturer must furnish a new part at no charge.

Provide a minimum warranty of five years for the paint finish on doors and frames.

55-4.02 MATERIALS

55-4.02A General

Comply with Section 55-1.02 except as modified herein.

55-4.02B Delivery, Storage, and Handling

Deliver manufactured products in manufacturer's original packaging.

Store materials in a dry, protected, and well-ventilated area. Store materials on wood platforms or a method that prevents contact with the ground.

Inspect materials upon receipt and report damaged material immediately to delivering carrier. Note such damage on the carrier's freight bill of lading.

55-4.02C Structural Steel

Provide ASTM A709/A709M, Grade 50 structural steel that is galvanized in accordance with section 75-1.02B.

55-4.02D Steel Pipe

Provide steel pipe conforming to ASTM A53/A53M, Type F, Schedule 40. Galvanize steel pipe in accordance with ASTM A123/A123M after fabrication.

55-4.02E Anchor Bolts

Provide galvanized anchor bolts conforming to section 55-1.02D, Gr. 55.

55-4.02F Neoprene

Provide neoprene sheet conforming to ASTM D2000 M2BC with a Shore A durometer hardness of 60 ± 5 according to ASTM D2240.

55-4.02G Safety Gate

Provide an industrial swing gate with self-closing hinges constructed of tubular steel. Galvanize the industrial swing gate according to ASTM A123/A123M after fabrication. Provide a gate that is capable of meeting U.S. Federal OSHA Loading Requirements.

Use access gate framing that is steel square tubing with minimum dimensions of 1¼ inch by 1¼ inch. Minimum dimension from top of gate arm to bottom of gate arm must be 22 inches.

Provide gate tubing that is either carbon steel tubing that meets the requirements of ASTM A500 or formed mild steel with a minimum thickness of 11-gauge and meets the requirements of ASTM A1011. Provide gate framing with length adjustment to allow modifications for existing conditions.

Provide all hinges, latches, clamp brackets, and other required hardware for installation of the access gate that are galvanized.

Provide torsion type, galvanized hinge springs. Use a minimum of two springs per gate.

Do not order any materials until approval of specifications and shop drawings are received from the Engineer.

55-4.02H Access Hatches

Furnish and install access hatches that are pre-assembled from the manufacturer.

Provide access hatches that meet the following requirements:

1. Supports a minimum live load of 40 psf with a maximum deflection of 1/150th of the span or 20 psf wind uplift.
2. Operates smoothly throughout the entire arc of opening and closing.
3. Operation is not affected by temperature.
4. Is weather-tight with fully welded corner joints on covers and curb.
5. Includes safety railing at locations indicated on the plans.
6. Includes one integrated aluminum stair tread at pier roof hatch as shown in the plans.
7. Includes provisions for connecting the ladder at the electrical room hatch as shown in the plans.
8. Includes provisions for locking access hatch doors.

Provide a minimum 11 gauge aluminum cover with beaded flange and formed reinforcing members. Provide access hatch with extruded EPDM rubber gasket bonded to the cover.

Provide curb that is a minimum of 11 gauge aluminum formed with a flange for securing to the surrounding concrete.

Provide compression spring operators enclosed in telescopic tubes as lifting mechanisms. Provide tubes that are enclosed to prevent accumulation of debris, moisture, and grit.

Provide mill finish for the aluminum.

Provide access hatch hardware meeting the following:

1. Heavy pintle hinges
2. Enclosed spring latch with interior and exterior turn handles
3. Interior and exterior padlock hasps
4. Latch strike that is bolted to the curb assembly
5. Rigid hold open arm in the open position with a handle for closing
6. Type 316 stainless steel

Key all access hatch locks alike. Furnish four copies of the access hatch key to the Engineer.

Provide safety railing for the access hatches meeting the following:

1. High visibility safety yellow powder coat paint finish
2. Attaches to the capflashing of the access hatch
3. Conforms to the requirements of OSHA 29 CFR 1910.29 and meets OSHA safety requirements with a factor of safety of two
4. Corrosion-resistant construction
5. Hinged gate with continuous barrier around the access hatch
6. Self-closing gate hinge and positive latching system
7. Posts and rails consisting of 6061 T6 schedule 40 aluminum pipe
8. Aluminum mounting brackets
9. Pivoting post guides with compression fittings and latching mechanism that are cast aluminum
10. Self-closing hinges and fasteners that are Type 316 stainless steel

11. Provided by the same manufacturer as the access hatch

Galvanized steel must not be in direct contact with aluminum. Provide isolation in the form of nylon or neoprene between galvanized steel and aluminum.

55-4.02I Doors

Provide steel exterior doors conforming to ANSI/SDI A250.8 "Specification for Standard Steel Doors and Frames" and the following:

1. Classification Level: 3 (extra-heavy duty)
2. Model: 1 (Full flush)
3. Physical Endurance: A
4. Door Thickness: 1-3/4"
5. Face: ASTM A653/A653M, A60, Commercial Steel (CS), Type B, metallic-coated steel sheet

Provide steel door frames conforming to ANSI/SDI A250.8 "Specification for Standard Steel Doors and Frames" and the following:

1. Classification Level: 3
2. Material: ASTM A653/A653M, A60, Commercial Steel (CS), Type B, metallic-coated steel sheet

Provide frame anchors conforming to ANSI/SDI A250.4 "Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors."

Shop finish doors and frame with a primer and finish coat in accordance with ANSI/SDI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

Provide hardware conforming to ANSI/BHMA A156 series and the following:

1. Locksets: Stainless steel and/or bronze conforming to ANSI/BHMA A156.2 "American National Standard for Locks and Latches." Provide finish as directed by the Engineer. Key all locks alike and furnish four keys.
2. Closer: Steel automatic closer conforming to ANSI/BHMA A156.4 "American National Standard for Door Closers and Pivots." Finish to match the lockset.
3. Hinges: Ball bearing, loose pin steel hinges conforming to ANSI/BHMA A156.1 "American National Standard for Butts and Hinges." Finish to match the lockset.

55-4.02J Grout

Provide grout conforming to section 51-1.02G.

55-4.02K Removable Platform

Design removable platform that can be removed to access the machinery through the machinery access opening in the pier roof.

The removable platform will be used to temporarily hold machinery and/or equipment prior to being lifted out of the pier.

Provide design and materials for the removable platform and supporting framework that meet the following requirements:

1. Design removable platform and supporting framework using loads and capacities in accordance with AASHTO LRFD Bridge Design Specifications with California Amendments. In addition, design removable platform and supporting framework for a concentrated load of 30,000 lb for machinery or equipment.
2. Design removable platform and supporting framework using structural steel in accordance with section 55-1.
3. Provide lifting hooks for removal of the removable platform through the pier roof.
4. Attach removable platform to supporting framework so that it is easily detachable when access is required, but safe and stable when in place.
5. Provide steel grating for removable platform surface with a bonded non-slip surface.

6. Provide a ladder to access the removable platform. Design ladder to conform to OSHA and other applicable codes.

Supporting framework for the removable platform shown in the drawings is for informational purposes only. Provide design calculations to verify the supporting framework meets the design described herein. Alternate designs of the supporting framework may be submitted for approval.

55-4.03 CONSTRUCTION

55-4.03A General

Comply with section 55-1.03 except as modified herein.

55-4.03B Safety Gate

Install safety gate in accordance with the manufacturer's installation instructions.

55-4.03C Access Hatches

Prior to construction, examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

Where required, level the installation surface using a grout pad.

Install access hatches and safety railing in accordance with manufacturer's instructions and approved submittals. Locate units level, plumb, and in proper alignment with adjacent work.

Test access hatches and self-closing gates for proper function and adjust until proper operation is achieved.

Repair finishes damaged during installation at no additional expense.

Restore finishes so no evidence remains of corrective work.

Clean exposed surfaces using methods acceptable to the manufacturer which will not damage finish.

55-4.03D Pipe Handrailing

Install pipe handrailing in accordance with section 83-2.09 except as modified herein.

55-4.03E Doors

Install door frames plumb, level, rigid and in true alignment as recommended in ANSI/SDI A250.11, "Recommended Erection Instructions for Steel Frames" and DHI "Installation Guide for Doors and Hardware". Fasten frames to the adjacent structure to retain their position and stability.

Install and fasten doors to maintain alignment with frames to achieve proper operation and appearance. Adjust doors to maintain perimeter clearances as specified in ANSI/SDI A250.8 "Specification for Standard Steel Doors and Frames". Perform shimming as needed to ensure the proper clearances are achieved.

Install hardware in accordance with the hardware manufacturer's recommendations and templates. Consult DHI "Installation Guide for Doors and Hardware" and ANSI/SDI A250.6, "Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames" as required.

55-4.04F Removable Platform

Install removable platform and supporting framework in accordance with the relevant sections with the Standard Specifications and these Special Provisions.

55-4.04 PAYMENT

Payment will be made at the contract lump sum price. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to complete the access system as shown on the plans and as described herein.

Steel grating and FRP grating are not included with this item.

Replace section 55-5 with:
55-5 CENTERING DEVICE

55-5.01 GENERAL

55-5.01A Summary

Section 55-5 includes furnishing, fabricating, and installing the centering devices.

55-5.01B Definitions

Not Used

55-5.01C Submittals

Provide submittals in accordance with section 55-1, except as modified herein or on the plans.

Submit the following:

1. Detailed shop drawings of the centering device.
2. Detailed methods and sequence for installation, including proposed methods for adjustment.
3. Detailed methods, calculations, and/or shop drawings for compensation of wind load for proper installation of the centering device.
4. Detailed procedure for field milling of the embedded base plates or grillage plates, including any equipment utilized and methods employed to determine the proper profile, alignment, and geometry.
5. Any manufacturer's literature, where applicable.

Submit at least thirty (30) days prior to fabrication. Do not commence work until submittals have been approved by the Engineer.

55-5.01D Quality Assurance

Not Used

55-5.02 MATERIALS

Provide materials conforming to section 55-1, except as modified herein or on the plans.

55-5.03 CONSTRUCTION

Perform work in accordance with section 55-1, except as modified herein or on the plans.

Mill the top surface of the embedded base plates and grillage plates in the field. In their final condition, each plate must have a flatness within 0.015 inches of a level plane passing through the median elevation of the top of the plate. Provide a final surface roughness of each plate of 125 μ in RMS. Ensure that the final median elevation is within 0.125 inches of the elevation provided in the plans. The final thickness of the embedded base plate or grillage plate must not be less than 2.00 inches.

Field-apply a prime coat to the top surface of the embedded base bearing plates after milling.

55-5.04 PAYMENT

Payment will be made at the contract unit price per each centering device. Payment includes full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete this work as shown on the plans and as specified herein.

One centering device consists of one lower centering device and two pieces of the upper centering device as shown in the plans.

Replace section 55-6 with:
55-6 STEEL GRATING

55-6.01 GENERAL

55-6.01A Summary

Section 55-6 includes furnishing and installing steel walkway grating.

55-6.01B Definitions

bearing bars: Load-carrying bars made from steel strip or slit sheet extending in the direction of the grating span.

cross bars: The connecting bars, made from steel strip or slit sheet, which extend across the bearing bars, usually perpendicular to them. They may be bent into a corrugated or sinuous pattern and, where they intersect the bearing bars, are welded, forged, or mechanically locked to them.

load-carrying band: A band used to transfer the load between bearing bars.

55-6.01C Submittals

Submit the manufacturer's catalog pages including load tables, anchor details, and standard installation details.

Submit shop drawings for the fabrication and erection of all gratings for approval to the Engineer. Include plans, elevations, details of sections and connections, and details and design of grating access hatch, as required. Show type and location for all fasteners.

Submit samples of grating and anchorage system to Engineer for approval.

Submit documentation showing that the manufacturer meets the experience requirements herein.

If requested, submit records of dimensional inspections, galvanizing thickness tests, and any shop assembly fit-up tests.

55-6.01D Quality Assurance**55-6.01D(1) General**

Perform work in accordance with ANSI/NAAMM MBG 531 Metal Bar Grating Manual and ANSI/NAAMM MBG 533 Welding Standards for Fabrication of Steel, Stainless Steel, and Aluminum Bar Grating.

55-6.01D(2) Manufacturer's Qualifications

Utilize a manufacturer with at least five years' experience manufacturing metal bar gratings.

55-6.02 MATERIALS**55-6.02A General**

Mark panels for identification and match-marking with permanent ink or weather-resistant tags.

55-6.02B Delivery, Storage, and Handling

During transport and storage, support and protect panels to prevent distortion or damaging the grating or zinc coating.

Store panels off the ground using timber blocking. Place blocking at points to prevent sagging. Keep panels dry during storage.

Use nylon slings or other non-abrasive lifting devices to avoid scratching the galvanized coating.

55-6.02C Steel Grating

Steel used in bearing bars, cross bars, and connecting bar of rectangular section must conform to ASTM A1011/A1011M Commercial Steel (Type B) for hot rolled carbon steel sheet and strip.

Cross bars made of wire rod must conform to ASTM A510/A510M for carbon steel wire rods and coarse round wire, except that permissible tolerance on diameter of coarse round wire must be ± 0.005 in. Combinations of these steels are permitted to be welded together.

Galvanize steel gratings according to ASTM A123/A123M after fabrication.

Apply a metal-bonded anti-slip coating to the top surface of the steel grating with a minimum Wet Dynamic Coefficient of Friction of 0.45 to meet high traction classification when tested per ANSI A326.3. The anti-slip coating must be compatible with hot dip galvanizing. Apply anti-slip coating after fabrication, but before galvanizing.

Unless specifically noted otherwise, do not grind welds anywhere on the grating.

Use load-carrying bands at all cutouts where more than one bearing bar is cut and bearing bars are not supported.

Grating access hatch is a removable panel of the grating, which can be removed for access below.

55-6.03 CONSTRUCTION

Take field measurements prior to preparation of final shop drawings and fabrication to ensure proper fit of work.

Prior to installation, inspect supports for correct alignment and conditions for proper attachment of the steel grating. Support ends of all bearing bars at cutouts or penetrations.

Install grating in accordance with the manufacturer's installation instructions and ANSI/NAAMM MBG 531 Metal Bar Grating Manual.

Repair damaged galvanized coatings in accordance with ASTM A780/A780M.

55-6.04 PAYMENT

Payment will be made at the contract unit price per square foot of steel grating installed. Payment includes full compensation for all labor, materials, tools, equipment, labor, and incidentals necessary to furnish and install steel grating as shown on the plans and as specified herein.

Payment quantity for steel grating is the gross surface area of the grating, as measured from the outside edge to the outside edge of the steel grating in both directions. Deductions for cut-outs in the steel grating will not be made.

56 OVERHEAD SIGN STRUCTURES, STANDARDS, AND POLES

Add to section 56-3.01C(1):

The sign mounting hardware must be installed at the locations shown.

Install non-illuminated street name signs on signal mast arms using a minimum 3/4 by 0.020-inch round edge stainless steel strap and saddle bracket. Wrap the strap at least twice around the mast arm, tighten, and secure with a 3/4-inch stainless strap seal. Level the sign panel and tighten the hardware securely.

Set the Type 1 standards with the handhole on the downstream side of the pole in relation to traffic or as shown.

59 STRUCTURAL STEEL COATINGS

Add to section 59-3.03:

For the California ST-75 bridge rail and tubular bicycle railing on bridge no. 22C0193, the exposed surfaces of the type B luminaire lighting supports on Bridge no. 22C0193 and retaining walls, the conical steel sleeve and steel cap for the Precast Traffic Warning Gate Monuments, and the tubular railing (retaining wall) on retaining wall No. 2 and No. 3, the 2nd finish coat must match color no. #27875 (Insignia White) of AMS-STD-595.

Replace section 59-6 with:
59-6 ANTI-SLIP COATING

59-6.01 GENERAL

59-6.01A Summary

Section 59-6 includes specifications for coating the hanger floor support beams with an anti-slip coating.

59-6.01B Definitions

Not Used

59-6.01C Submittals

Submit test reports to the Engineer for review. Clearly state the method of testing and the results in the report.

59-6.01D Quality Assurance

Use independent laboratory testing methods to verify the proposed anti-slip coating properties shown herein.

59-6.02 MATERIALS

Furnish an anti-slip medium profile coating with a minimum pendulum test value (PVT) of 36. Use a Martensitic alloy having a hardness of at least 55 on the Rockwell "C" scale. Ensure the surface-to-substrate bond strength is at least 4,000 psi.

Anti-Slip Coating Physical Properties and Test Methods

<u>Physical Property</u>	<u>Test Method</u>
<u>Pendulum test value (PVT)</u>	<u>ASTM E303</u>
<u>Bond strength of surfacing substrate</u>	<u>ASTM C633</u>
<u>Hardness of surfacing</u>	<u>ASTM E140/E384</u>

59-6.03 CONSTRUCTION

Apply the anti-slip coating in the manufacturer's shop to the limits shown in the plans on the hanger floor support beams. Clean the surface of the steel in accordance with the anti-slip coating manufacturer's recommendations.

Apply the anti-slip coating to steel substrate using an all-metal plasma stream deposition process to bond the coating to the substrate, resulting in the primarily Martensitic steel coating having a random hatch matrix.

Replace defective or damaged anti-slip coatings as directed by the Engineer.

59-6.04 PAYMENT

Payment for the anti-slip coating will be included with Furnish Structural Steel (Bridge). No additional payment will be made for repair of defective or damaged anti-slip coatings.

60 EXISTING STRUCTURES

Add to section 60-2.01A:

Remove the following structures or portions of structures:

Bridge no./Structure name/Location	Description of work
22C0154 Sacramento River Approach (C Street Approach) Location A	Spans 6 through 11 and bents 6 through 10 and abutment 11 totaling approximately 325.5 ft length of superstructure approximately 41.3 ft max wide, simple span composite welded steel plate girder superstructure, welded steel bent caps, reinforced concrete seat abutments, columns, and abutment and column pile caps, as defined on the project plans.
24C0364R J Street Viaduct Location B	Span J₂₆13 starting at hinge through span 21 and bent I₃₀22 and bents J₃₂14 through J₃₂21 totaling approximately 624.1 ft of superstructure approximately 38 ft max wide, reinforced concrete box girder and precast prestressed concrete girder superstructure, concrete bent caps and columns as defined in the project plans.
24C0364L I Street Viaduct Location C	Spans 6 through 16, and bents 7 through 16 and abutment 17 totaling approximately 586 ft length of superstructure approximately 46.0 ft wide, reinforced concrete deck on steel beams on steel bents on reinforced concrete footings and close end-backfilled cantilever abutment and pile cap, as defined in the project plans.
24C0006 Jibboom Street Viaduct Location D	Spans 1 through 17 and bents 2 through 17 and abutment 18 totaling approximately 850 ft length of superstructure approximately 36 ft wide, reinforced concrete deck on hinged steel plate girders and rolled steel beams, steel frame bents and reinforced concrete seat abutment and pile caps, and staircase, as defined in the project plans.

Add section 60-6:

60-6 RELOCATING STRUCTURES

60-6.01 RELOCATE WATER TOWER

60-6.01A General

60-6.01A(1) Summary

Section 60-6.01 includes specifications for relocating the existing water tower.

60-6.01A(2) Definitions

Not Used

60-6.01A(3) Submittals

60-6.01A(3)(a) General

Not Used

60-6.01A(3)(b) WATER TOWER RELOCATION PLAN

Submit a water tower relocation plan detailing the procedures, sequences, and elements required to perform the water tower relocation in a safe and controlled manner. The water tower relocation plan must include:

1. The means and methods for lifting and relocating the water tower
2. The relocation sequence, including staging of relocation operations
3. Equipment locations during the relocation operations
4. Any required temporary supports or bracings as determined by the contractor
5. Details, locations and types of protective covers to be used
6. Measures to ensure that people, property, utilities, and improvements will not be endangered
7. Calculations verifying that the water tower will remain undamaged by the relocation process and stable in its final location

8. Calculations and details for the tower support pinned connection replacements

The water tower relocation plan must be prepared, stamped, and signed by an engineer who is registered as a civil engineer in the State of California.

Allow 30 days for review.

60-6.01B Materials

Not Used

60-6.01C Construction

Not Used

60-6.01D Payment

Not Used

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DIVISION VIII MISCELLANEOUS CONSTRUCTION

75 MISCELLANEOUS METAL

Replace note b in section 75-1.02B with:

^bFor threaded studs, bolts, nuts, and washers specified to comply with ASTM A307; F3125, Grade A325; A449; A563; F436; F1554, Gr. 36; or F1554, Gr. 55, galvanize under their ASTMs. For ASTM F1554, Gr. 105, galvanize in accordance with ASTM B695.

Add to the list in the 2nd paragraph of section 75-3.01A:

6. Soffit access opening covers
7. Base plates and J-bolts

Add to the end of section 75-3.01A:

Bridge deck drainage system consists of:

1. Inlets
2. Pipes
3. Pipe Hangers
4. Expansion Couplings

77 LOCAL INFRASTRUCTURE

Replace section 77-1 with:

77-1 GENERAL

77-1.01 GENERAL

77-1.01A Summary

Section 77-1 includes general specifications for constructing City of Sacramento Signal and Lighting infrastructure.

All City of Sacramento equipment to be salvaged shall be returned to the City of Sacramento Corporation Yard. The City has two corporation yards: Corporate Center South, 5730 24th Street, Building 11, Sacramento,

California and the Corporate Center North, 918 Del Paso Road, Sacramento, California. Contractor is responsible to provide machinery and manpower to unload and load all salvaged equipment. Loading, unloading, pick-up, and delivery of these items will be considered included in the price bid for various items and no additional compensation will be allowed therefor.

The Contractor shall schedule the delivery of salvaged equipment with the City Inspector. Equipment drop-off shall be done in the presence of the City Inspector or his designated representative. The Contractor shall be responsible for all damages that occur in connection with the care and protection of all City salvaged equipment.

77-1.01B Definitions

Not Used

77-1.01C Submittals

Not Used

77-1.01D Quality Assurance

Not Used

77-1.02 MATERIALS

Not Used

77-1.03 CONSTRUCTION

Not Used

77-1.04 PAYMENT

Not Used

77-2 CONDUIT MATERIALS

JM Eagle and PW Eagle are not acceptable conduit materials.

A. General – Schedule 40

Conduit to be installed underground shall be Schedule 40 polyvinyl chloride (PVC) or Schedule 40 polyethylene conduit as described herein unless otherwise indicated or specified. PVC conduit shall comply with the specifications in Section 34-11 of the City Standard Specifications. High-density polyethylene conduit shall comply with the following specifications:

Conduit shall be fabricated from polyethylene shall be in conformance with applicable ASTM and NEMA standards and Article 347 of the National Electrical Code. Non-black polyethylene conduit shall contain not less than 2500 parts per million (ppm) of a hindered amain ultraviolet light stabilizer. Ultraviolet stabilization additive for black polyethylene conduit shall consist of a carbon black loading of 2.5% □ 0.5% by weight.

Conduit shall be manufactured from high-density polyethylene resin designated as Type III, Category 5, Class C, Grade P34 material in accordance with ASTM D1248.

Duct seal shall be installed on all conduits.

All new conduits starting/terminating in pull boxes shall have End Bells.

B. High Density Polyethylene (HDPE) Conduit

HDPE conduit shall be manufactured to UL 651A specifications, compliant with NEC Article 353, and Schedule 40, unless otherwise specified. HDPE conduit shall have high tensile strength-to-weight ratio, crush resistance, low coefficient of friction for directional drilling.

77-3 CONDUIT INSTALLATION

Conduit installation shall be in accordance with Section 34-11 of the City of Sacramento Standard Specifications and as modified by these Special Provisions. "Jet-rodging" is not permitted.

Conduits terminating in pull boxes, standards, pedestals and cabinets shall rise vertically and shall not slope in any direction. Conduits terminating in standards, pedestals, and cabinets shall terminate one and one-half inches (1½") above finished grade. Conduits shown on the Plans to be adjacent and parallel to each other shall be installed in the same trench or drill hole unless otherwise specified or directed by the Engineer. Under the sidewalk, conduit shall be laid to a depth of not less than eighteen inches (18") below the sidewalk grade.

Conduits shall be installed by trenching or directional drilling method.

All applicable requirements in these Special Provisions to locate, and to protect existing utilities, utility laterals, obstructions, and other facilities in the area shall be conformed to and no additional compensation will be allowed therefor. Contractor is responsible for any damage and the repair of any existing facilities damaged by his/her trenching or drilling operations. Contractor is responsible for any potholing necessary and cost for potholing shall also be included in price paid for applicable items of work and no additional compensation will be allowed therefor. All trenching or drilling work shall be contained within the City right-of-way. If utilities or other obstacles are encountered at the specified conduit depth, any additional drilling required to avoid the obstacle shall be made at the Contractor's expense and no additional compensation will be allowed therefor. Location of trenching and drill holes shall take into consideration minimal impact to the street pavement while still meeting the requirements of these Special Provisions.

Contractor shall replace roadway striping and markings with same material if damaged by directional drilling, bore pits, potholes, or trenching. Replacement striping and markings shall be thermoplastic or paint, per the City of Sacramento Standards.

Contractor shall use the following PVC pipe cement to join conduits and fittings: Premier Cement PVC All Temperature One Step Blue or Christy's Red Hot Blue Glue for Schedule 80 thru 4" diameter.

A. Trenching Method

Installation of conduit by trenching shall be in conformance with the Plans and these Special Provisions. See plan sheets for trench details. Trenches shall be backfilled or covered at the end of each work day. All conduit installed by trenching shall be anchored every 15 feet to the bottom of the trench, with an approved method, so as to prevent the conduit from floating when the concrete is backfilled into the trench.

1. Trenches in reconstructed roadways shall be backfilled with slurry portland cement per cubic yard and fine type aggregate as defined in the Standard Specifications Section 10-5. A red oxide in the amount of 5 lbs. per cubic yard shall be mixed uniformly throughout the slurry cement. See plan sheets for amount of sack slurry and depth of conduit(s).
2. Trenches in existing roadways shall use the "T-Trench" method. The portion over the trench shall be paved with asphalt concrete, Type A with ¾" aggregate (coarse); except on residential streets where the base course shall be Type A, ¾" aggregate (coarse) and surface coarse shall be Type B, ½" aggregate, (medium), per Section 22 of the City Standard Specifications, unless otherwise directed by the Engineer. See plan sheets for width and thickness of asphalt concrete over trench. Trenches shall be backfilled with slurry portland cement per cubic yard and fine type aggregate as defined in the Standard Specifications Section 10. A red oxide in the amount of 5 lbs. per cubic yard shall be mixed uniformly throughout the slurry cement. See plan sheets for amount of sack slurry.

B. Directional Drilling Method

Installation of conduit by directional drilling shall be in conformance with the Plans and these Special Provisions.

Conduits shall be installed such that the top of the conduit(s) are not less than eighteen inches (18") below the finished grade in sidewalk areas and not less than thirty inches (30") in all other areas except as otherwise specified or directed by the Engineer.

Prior to the start of directional drilling, the Contractor shall submit a plan which identifies location and size of proposed drill holes, describes process for identifying/locating existing utility services and other underground utilities or obstructions, identifies a proposed "drilling corridor" to avoid conflicts with existing utilities, services and other facilities. This plan shall be submitted to the Engineer a minimum of ten (10) working days prior to the start of work. The Contractor will not be allowed to directional drill until an approved plan is on file with the Engineer

Directional drilling shall be performed by the technique of creating and directing a bore hole along a predetermined path to a specified targeted location where indicated on the plans to install conduits. The technique shall involve the use of mechanical and hydraulic equipment to change the boring course and shall use instrumentation to monitor the location and orientation of the boring head assembly along the predetermined course. Drilling shall be accomplished with fluid-assisted mechanical cutting. Unless otherwise approved, boring fluids shall be a mixture of bentonite and water or polymers and additives. Bentonite sealants and water will be used to lubricate the drilling head. It is mandatory that minimum pressures and flow rates be used during drilling operations so as not to fracture the subgrade material around and/or above the bore. Uncontrolled jetting (where the primary purpose is to use fluid force to erode soil for creation of the final bore hole diameter) is prohibited. The drilling system shall utilize small-diameter fluid jets to fracture, and mechanical cutters to cut and excavate the soil as the head advances forward.

All drilling shall be located a minimum of three feet (3') from the center of all existing maintenance holes. Drilling that run parallel to any sanitary sewer or storm drainage lines shall maintain a minimum clearance of three feet (3') measured from the centerline of the sewer or drainage line to the adjacent side of the drill hole. Drilling that crosses any sewer or drainage line shall cross at 90 degrees to the line or at a minimum of 45 degrees if a 90 degree crossing is not possible.

77-4 CONDUCTORS

Conductors shall be in accordance with Section 34 13 of the City of Sacramento Standard Specifications, except for the following:

1. If the existing ground wire (green 1#10 THW) is used as a pull wire, a new ground wire shall be pulled with the new conductors or cables, unless otherwise specified.
2. Unless otherwise noted, insulation Types THHN and THWN are not approved for installation.
3. The electrolier leads from base to lamp socket shall be No. 12 THW solid wire with 45 mils insulation suitable for 600-volt service for historic decorative, post top and mast arm electroliers.
4. All conductors of AWG #10 or larger shall be identified by printed and embossed labels. #1, #6, #8, #10 conductors shall be printed and embossed.
 - a) Both printed and embossed labels shall clearly identify the UL listing, insulation type, voltage rating, AWG number, and the City of Sacramento.
 - b) The printed label and the embossed label shall be placed at approximately 90 degrees separation around the center of the conductors.
 - c) Labels shall appear every one foot interval. Embossed labels shall be between 0.002" to 0.003" in depth and shall not damage the conductors. Label heights shall be no less than 3/32" for AWG #8 or larger, and shall be no less than 2/32" for AWG #10.

77-5 COMMUNICATION EQUIPMENT

The following communication equipment shall be provided, installed and configured per the Plans and Special Provisions.

- A. Fiber Network Switch with Power Supply

Network Switch shall be manufactured by Cisco, Model IE-3100-8TC2-E or approved equal.

All Cisco hardware, software, licensing, and SmartNet must be new and procured through a Cisco Gold authorized reseller and validated by the Cisco Account Manager for the City of Sacramento. Jason Kaiser is our local representative and can be reached at jakaizer@cisco.com or (408) 895-2841. All purchases must be registered with Cisco under the City of Sacramento Traffic Engineering name and contracts associated with City of Sacramento Traffic Engineering department's CCO ID's upon 30 days of procurement.

CCO ID = City of Sacramento-DOT (35036) 1019538262

Address = 915 I Street, Room 2117, Sacramento, CA 95814

The network switch shall have the following:

- Model IE-3100-8TC2-E
- Power Supply shall be Cisco, PWR-IE50W-AC-IEC.
- Two (2) GLC-LX-SM-RGD – Small Form Factor Pluggable Module
- 19" DIN Rail mount kit STK-RACK-DINRAIL

Network Switch shall meet the following requirements:

- Industrial grade
- DIN rail mountable
- Ethernet connectivity
- Operate under 14 degrees Fahrenheit to 140 degrees Fahrenheit, and under vibration and shock
- Eight (8) 10/100 Base-T Ethernet ports and 2 Small Form Factor Pluggable (SFP) ports
- Two (2) gigabit combo ports: SFP
- Swappable SD flash card and mini-USB connector
- LAN base (OS) Software license
- Switch shall have MAC address security function for each port
- Switch shall have Vlan function for each port
- 5-year warranty

Power Supply for Network Switch shall meet the following requirements:

- Compatible with Cisco IE 2000 Series industrial grade switch
- DIN rail mountable
- Input: 100-120 VAC or 200-240 VAC, manually selected AC, 50-60 Hz
- Operate under 14 degrees Fahrenheit to 140 degrees Fahrenheit, and under vibration and shock
- 5-year warranty
- Power Supply for Network Switch shall be installed in cabinet.

Small Form Factor Pluggable Module Cisco 100Base – X small Form Factor Pluggable Module - Two (2) GLC-LX-SM-RGD – Cisco device hot-swappable I/O device that plugs into Fast Ethernet ports, dual-rate Fast/Gigabit Ethernet ports, or Gigabit Ethernet ports of Cisco Switch linking the port with the fiber cabling network or approved equal.

Functional Test

The Fiber Network Switch shall be powered up and ready to be programmed. City will program switch to connect to city traffic network. Switch Functional test is passed once city as performed network test to prove network operability.

B. Surge Suppressor Power Strip

Surge Suppressors shall meet the following requirements:

For 342LX Cabinet, Surge Suppressors shall be manufactured by Tripplite, model ISOBAR12ULTRA. 12 outlet.

- 120 VAC, 60 Hz, 3,840 joule surge protection, 150,000 Max surge Amps, 15 ft cord. 12 outlet.

Surge Suppressors are to be installed in cabinets at locations where a network fiber or DSL switch are being installed as noted on the Plans. For the Type 342LX cabinet, the Surge Suppressor shall be mounted on 2" aluminum stock on the back side of the cabinet near the top using the 19" rack. The Surge Suppressor must be plugged into the equipment receptacle on the back of the power assembly of the cabinet. See Plans for further details.

77-6 CCTV CAMERA SYSTEM

A. General

The CCTV Camera shall be AXIS P3738-LE Panoramic Camera or pre-approved equal. System shall include PoE mid-span power injector, mounting brackets and cat 6 cabling.

The CCTV system for traffic monitoring shall connect to the city network through the Ethernet switch in the traffic signal cabinet. All cabling between the camera and the traffic signal cabinet shall be Category 6 (CAT6) outdoor rated communication cable. Camera shall be powered over the data cable via a mid-span high Power over Ethernet (PoE) injector. The Camera shall be rated commercial/industrial 24/7/365 outdoor uses. The camera shall be able to be tilted above horizon. The camera shall have an open and published API (Application Programmers Interface), allowing for integration with third party applications and it shall conform to the network video standard as defined by the ONVIF organization. Camera shall be equipped with a HTTP accessible web server to allow for programing, configuration, video streaming and PTZ controls, without the need for additional software.

B. Components

The camera system shall have following components:

Manufacturer	Model Number	Description
AXIS	P3738-LE	Quad Panoramic Camera
AXIS	02172-004	30 Watt High power PoE Mid-Span power Injector
Belden	7927A	Outdoor Rated Cat6 Cable
Pelco	AB-3035	Astro-Brac for Mastarm, Luminaire Arm mounting
AXIS	TQ6501-E	Parapet Mount
AXIS	39680	RJ45 Push Pull connector
Belden	7927A	Category 6

C. Camera

The camera enclosure shall meet IP66 and NEMA 4X -. The dome shall be clear acrylic (PMMA) and include a sunshield (PC/ASA). The camera shall be IP based and support Motion JPEG and H.264 encoding, providing at least three individually configured video streams capable of 30 frames per second at resolution between 176x120 and (D1) 1920x1080 pixels or higher, using both Constant (CBR) and Variable (VBR) Bit Rates. It shall have high-speed pan and tilt control with a 360° endless pan range and a 220° tilt range and speeds

between 0.05° - 450°/sec. The lens shall be least a 30x optical providing a horizontal angle of view between 60° and 2° at tolerance of ±3° and be capable of 12x digital zoom. The camera shall have the ability set up to 100 pre-set positions. The lens shall have aperture capable of F1.4 – F4.6. It shall be equipped with Day/Night functionality, using a high quality IR-sensitive progressive scan CCD sensor. CCD sensor shall be able to provide pictures in lighting conditions down to 0.2 lux at F1.4 while in day mode (with IR-filter in use) and down to 0.04 lux while in night mode (with IR-filter removed). It shall incorporate automatic and manual white balance wide dynamic range functionality. It shall be capable of uploading and storing images and video recording via FTP, SMTP or HTTP or to local storage and shall include an expansion slot for a SD/SDHC memory card. Camera shall be powered with a PoE mid-span injector that meets high Power over Ethernet IEEE 802.3at standard.

D. Camera Interface

The camera shall connect to the traffic signal cabinet with Category 6 (CAT6) outdoor rated communication cable. All cable connections shall be CAT6 rated.

Camera power shall be over the data cable via PoE injector. All data ports shall be 100BASE-TX Fast Ethernet-port, support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex). The Camera shall be automatically detected using UPnP and Bonjour standards and provide support for both IPv4 and IPv6. The camera shall support both fixed IP addresses and dynamic IP addresses.

Camera shall connect through the network to the City's existing Milestone 2016 video management control software. The camera shall be fully capable of working with Milestone software and shall allow full control of PTZ, focus, iris, and be able to present and display all video streams.

E. Mid-Span High Power over Ethernet (PoE) injector

The PoE injector shall power the camera and provide RJ-45 sockets for data passing through at 10/100/1000 Mbits per second. The injector shall have an input power of 100-240 Vac and be able to output at 55 Vdc at 1.35 amps. The injector shall meet the following standards IEEE 802.3af, IEEE 802.3at. The PoE injector shall be located in the traffic signal cabinet.

F. Communication- Power Cable and connectors

The camera shall connect PoE injector with Category 6 cable. The cable shall be Belden 7927A Multi-Conductor - Category 6 DataTuff® cable. See Outdoor Ethernet Communication cable section of these special provisions. The cable shall connect to the camera with a RJ45 Push Pull connector meeting IP66 environmental requirements and to the PoE injector with a standard RJ-45 connector.

G. Functional Test

The camera shall be installed and wired per the manufacturer's recommendations and shall power up and have a viewable video feed. Camera shall be fully controllable.

77-7 CATEGORY 6 OUTDOOR ETHERNET COMMUNICATION CABLE

All Ethernet communication cable placed in pole and conduits shall be Belden Part 7927A DataTuff Cat 6, 4 pair, 23awg Solid BC, PO/PVC, CMR. The cable shall have 23 AWG Bonded-Pair solid bare copper conductors, polyolefin insulation, E-Spline center member, industrial grade sunlight- and oil-resistant PVC jacket, rip cord. Sequential marking at two foot intervals. Connection for the cable it shall use Cat6 approved connectors. Cable shall meet NEC Specifications CMR, UL444, TIA 568.C.2 and NEMA WC-63.1, Category 6. Belden 7953A

77-8 CATEGORY 6 COMMUNICATION CABLE CONNECTOR

CATEGORY 6A FIELD MOUNT PLUG, 568A/B, UTP, LARGE AWG 22-24 (0.043 - 0.063 IN.) CAPFMUL-S1 Modular Connectors - FIELD MOUNT PLUG CAT6A UTP, LARGE AWG 22-24.

77-9 DETECTOR CONDUCTOR LOOP**A. Loop Conductors**

Each loop conductor shall be continuous, unspliced, Type RHW-USE neoprene-jacketed or Type USE crosslinked polyethylene insulated No. 12 stranded copper wire. Conductor insulation thickness shall be 40 mils minimum.

B. Loop Conductor Installation

Detector loop installation shall conform to these Special Provisions and the State Standard Plans, Sheet ES-5A.

Unless otherwise specified, each loop shall be three (3) turns of conductors for each detector loop. Unless otherwise shown or noted on the Plans, each new detector loop shall be 6' x 6' and centered in the travel lane.

Slots cut in the pavement shall be blown out with compressed air and dried and inspected for any sharp objects or corners which shall be removed prior to installation of loop conductors.

The loop conductors shall be installed in the slots using a 5/16" to 1/4" wooden paddle. As it is installed, the wire shall be kept under slight tension and shall be kept in the slots with suitable cardboard wedges. The cardboard wedges shall not be removed until the loop sealant operation requires removal.

Loop conductors shall be installed without splices and shall terminate in the Nearest pull box. The detector loops shall be joined in the nearest pull box in combination of series and parallel so that optimum sensitivity is obtained at the sensor unit. Final splices between loops and lead-in cable shall not be made until the operation of the loops under actual traffic conditions is approved by the Engineer. Each detector loop shall be identified and tagged by loop number, start (S), and finish (F). For example: Phase 4D1-1S & Phase 4D1-1F; Phase 4D1-2S & Phase 4D1-2F.

All loop conductors for each direction of travel for the same phase of a traffic signal system in the same pull box, shall be spliced to a cable which shall be run from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet. Splices to the cable shall be made in pull boxes only. All splices to the lead in cable and between loops and the lead in cable shall be soldered as specified in State Specifications in Section 86 2.09C, "Connectors and Terminals". Open flame soldering will not be permitted.

Each detector loop circuit shall be tested for continuity, circuit resistance, and insulation resistance at the controller location. The loop circuit resistance shall not exceed 0.50 ohms plus 0.35 ohms per 100 feet of lead-in cable. The insulation resistance shall be performed between each circuit conductor and ground. The megged insulation resistance shall not be less than 200 megohms. The Contractor shall replace any detector loop that fails this requirement at the Contractor's expense.

1. Depth of Loops and Conductors in the Traveled Way

All conductors and conductor loops installed in the traveled way shall be installed so that the top of the conductor is a minimum of one-inch (1") below the surface grade of the street.

2. Inductive Loop Sealant

Only the following methods may be used for inductive loop sealant:

Asphaltic Emulsion and Sand Method

1) Immediately after the loop wires have been installed, the slot shall be filled with an anionic asphaltic emulsion conforming to the State Standard Specifications for Rapid Setting No. 1 (RSI).

2) Dry 20 mesh sandblasting sand shall then be poured in and around the slot. A suitable and approved tool shall then be used to work the asphaltic emulsion up through the dry sand. The slot will then be inspected for any dry spots in the sandfill. Any dry sand spots will then be wetted with more asphaltic emulsion. More dry sandblasting sand shall then be added to the slot and the asphalt emulsion will again be worked up through the sand until a uniform mix of asphaltic emulsion and sand with no voids completely fills the slot to the level of the surrounding road surface. A final thin layer of sand will then be added to surrounding surface to absorb the

excess asphaltic emulsion. The traveled way may be opened to vehicular traffic immediately after installation of the asphaltic emulsion and sand loop sealant.

Hot-Melt Rubberized Asphalt Sealant Method

Hot-melt rubberized asphalt sealant shall conform to, and be installed in accordance with State Specifications Section 86-5.01A(5) and as directed by the Engineer.

Sackrit Method

After conductors are installed in the slots cut in the pavement, paint binder shall be applied to all vertical surfaces of slots in accordance with the provisions in Section 94, "Asphaltic Emulsions", of the State Standard Specifications. The slots shall then be filled with asphaltic concrete sealant.

Asphaltic concrete sealant shall be a mixture of sand and liquid asphalt. The percentage of sand in the asphaltic concrete sealant shall conform to the following:

Screen Size	Percentage Passing
#4	100%
#8	91%
#16	63%
#30	39%
#50	24%
#100	10%
#200	7%

The sand shall be uniformly mixed with six percent (6%) SC800 liquid asphalt conforming to Section 93 of the State Standard Specifications.

Temperature of sealant material during installation shall be above 70 degrees F. Air temperature during installation shall be above 50 degrees F. Sealant placed in the slots shall be compacted by use of an eight-inch (8") diameter 1/8" thick steel hand roller or other tools approved by the Engineer. Compacted sealant shall be flush with the pavement surface. Excess sealant remaining after rolling shall be reused. Traffic may be released immediately over compacted material.

C. Abandonment of Loop Conductor

Each detector loop shall be saw-cut in a minimum of two places.

77-10 DETECTOR HANDHOLES

Where shown on the Plans, detector loops shall be sawcut into detector handholes. Detector handholes shall be Type B and shall be installed as shown in Traffic Signals/Street Lighting Standard Details in the Plans sheets, unless otherwise noted or directed by the Engineer. No splicing will be allowed in the detector handholes. For detector handholes to be removed, holes or depressions resulting from the removed handhole shall be filled, compacted, brought to grade, and filled to match surrounding materials.

77-11 DETECTOR LEAD-IN CABLE

Detector lead in cable shall be "Canoga" Type 30003, or approved equal. Detector lead-in cable shall conform to the following Special Provisions:

Lead in cable shall consist of four (4) No. 18 A.W.G. stranded copper conductors insulated with nine (9) mils minimum of polypropylene, color coded, parallel laid, twisted together with four to six turns per foot. An amorphous interior moisture penetration barrier shall be provided to prevent hosing, siphoning, or capillary absorption of water along cable interstices. The outer jacket shall be thirty (30) mils minimum in thickness, high density polyethylene conforming to ASTM Designation: D 1248, 65T for Dielectric Material, Type I, Class C, Grade 5, J3. The diameter of the cable shall be approximately .25 inch.

Aluminum polyester shielding shall be applied around the conductors.

The detector lead-in cable shall be continuous from the pull box adjacent to the conductor loops to the controller unless otherwise shown on the Plans.

Splicing of detector lead-in cables to loop conductors and splicing of detector cables when called for on the Plans shall be as follows:

1. Splices shall be made in pull boxes only. All splices to lead in cable shall be soldered. The ends of the splice shall then be inserted into an approved insulated spring type connector of the correct size. When detector cables and detector loops are initially installed, precautions shall be taken to insure the cables and loops remain water tight prior to splicing. If splicing is not to be done immediately after installation, the ends of the conductors and cables shall be dipped in electrical insulating liquid which shall render them water tight. The insulating liquid shall be fast drying, resistant to oils, acids, alkalies and corrosive atmospheric conditions and shall be compatible with the insulations used in the conductors and cables. All conductors and cables shall be installed and splices shall be made in a dry environment.
2. The splice shall then be insulated by "Method B" of the State Standard Plans or as directed by the Engineer.

77-12 FIBER OPTICS

Fiber Optic Cable Requirements

Fiber optic cable shall be Corning Altos All-Dielectric Gel-Free or approved equal.

The Contractor shall use the following cable types as listed below or approved equal.

Fiber Strand

Description	Part Number	Manufacturer	Use
12 Strand	012ZU4-T4F22D20	Corning	Per Plan
24 Strand	024ZU4-T4F22D20	Corning	Per Plan
48 Strand	048EU4-T4F22D20	Corning	Per Plan
96 Strand	096EU4-T4F22D20	Corning	Per Plan

Fiber Patch Cable (OS2 Jumpers)

Description	Part Number	Manufacturer	Use
1m	040402G512001M	Corning	OS2 Jumpers
2m	040402G512002M	Corning	OS2 Jumpers

Fiber Patch Panel for In-Cabinet Use

Description	Part Number	Manufacturer	Description
48 strands	CCH-01U	Corning	High density cassette
96 strands	CCH-02U	Corning	High density cassette

144 strands	CCH-03U	Corning	High density cassette
288 strands	CCH-04u	Corning	High density cassette

Cable shall be all-dielectric, stranded loose-tube design with dry waterblocking for outdoor duct. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes shall be made from polypropylene. Each buffer tube shall contain a water swellable yarn or water blocking element for water blocking protection. The water-swellable yarn or water blocking element shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn or water blocking element will preclude the need for other water blocking material; the buffer tube shall be gel free. The optical fibers shall not require cleaning before placement into a splice tray or fan out kit. The buffer tube shall be manufactured to a nominal diameter of 2.5mm or 3.0 mm, regardless of fiber count, to reduce the number of required installation and termination tools.

Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B. Buffer tube colored stripes shall be inlaid in the tube by means of co extrusion when required. The nominal stripe width shall be 1 mm. Buffer tubes in a hybrid cable (cable containing more than one type of fiber) shall contain only one fiber type. Identification of fiber types in a hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation stranding process. Two polyester yarn binders shall be applied contra helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. For dual-layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water-swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. Cable shall be comprised of water-swellable yarns and/or tapes, dielectric strength members (as required), ripcord(s) and an MDPE jacket containing carbon black to provide ultraviolet light protection while inhibiting the growth of fungus.

Cable jacket shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code® (NESC®), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm. Cable shall contain reverse oscillation lay (ROL) markings as needed. Cable shall have a storage temperature range of -40° to 70°C, an installation temperature range of -30° to 70°C, and an operating temperature range of -40° to 70°C. Cable shall have a short-term tensile rating of 2700 N. No fiber strain shall occur over the service life of the cable when subjected to a maximum, long-term tensile rating of 890 N.

Cable shall meet the functional requirements of Rural Utilities Service (RUS) 7 CFR 1755.900 and be fully compliant with ICEA S-87-640. Manufacturer shall be ISO 9001 and TL 9000 registered. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support.

Fiber Characteristics Table	
Parameters	SM
Type	Step Index
Core Diameter	8.2 μm (nominal)
Cladding Diameter	125 $\mu\text{m} \pm 0.7 \mu\text{m}$
Core-Clad Concentricity	< 0.5 μm

Coating Diameter	245 $\mu\text{m} \pm 5 \mu\text{m}$
Cladding Non-Circularity Defined as: $[1 - (\text{min. cladding dia}) / (\text{max. cladding dia})] \times 100$	< 0.7%
Proof/Tensile Test	100 kpsi, (0.7 GPa) min.
Attenuation @ 1310 nm @ 1,550 nm	< 0.35 dB/km < 0.20 dB/km
Attenuation at the Water Peak	< 0.35 dB/km @ 1383 + 3 nm
Index of Refraction	1310 nm: 1.4677 1550 nm: 1.4682
Chromatic Dispersion Zero Dispersion Wavelength Zero Dispersion Slope	1313 nm < 0.086 ps/(nm ² *km)
Maximum Dispersion	3.3 ps/(nm*km) for 1285 - 1330 nm < 18 ps/(nm*km) for 1550 nm
Cut-Off Wavelength	< 1,260 nm
Mode Field Diameter Peterman II)	9.2 $\pm$ 0.4 μm at 1310 nm 10.4 $\pm$ 0.5 μm at 1550 nm

B. Fiber Optic Cable Installation

- Contractor shall install all fiber optic cable per manufacturer's recommendations and the City's Plans and Special Provisions.
- All splice work will be performed by City Approved Contractor. All patch panels and splice materials will be provided by City Approved Contractor.
- The Contractor shall test all fiber optic cable spans after installation (Bare Fiber Testing). Testing results must be provided to the City Inspector. The City shall review test results and accept or reject the cable within 5 working days. If accepted by the City, and the Contractor shall submit a request to the City to perform splice work. If rejected, the Contractor shall replace the cable and retest.
- The Contractor shall maintain a record of all sheath footage markings for each cable span. Hard and soft copy of all records shall be provided to the City with test results along with the program to review the soft copy of the test results.
- Existing fiber optic cable must be protected from damage. The Contractor shall contact the City Inspector twenty four (24) hours prior to working near any existing city fiber optic cabling.
- During installation, the tensile force shall not exceed 600 lbs. The Contractor shall use a break away swivel, or a slip-clutch capstan, set for less than 600 lbs. pulling tensile strength.
- Installation procedures shall be in conformance with the procedures specified by the cable manufacturer for the specific cable being installed.
- Fiber marking tags shall be installed on fiber optic cable in every pull box. The tags shall be non-adhesive, Hellermann-tyton 4" fiber optic marker, part number CMFO4 or approved equal.
- During cable installation, the bend radius shall be maintained at a minimum of twenty times the outside diameter of the cable.

10. Fiber optic cable shall be installed without splices except where specifically allowed on the plans or described in these special provisions. The need and approval for unplanned splices shall be reviewed by the engineer. Unplanned splices will be done at no cost to the City.

11. The Contractor shall install Arco Bull Line Part #WP12LC (with trace wire) or approved equal with the fiber optic cable.

C. Fiber Optic Cable Testing (Bare Fiber Testing):

All testing shall be performed according to the Telecommunications Industry Association (TIA) Technical Service Bulletin TSB-140, "Additional Guidelines for Field – Testing Length, Loss and Polarity of Optical Fiber Cabling Systems."

1. The Contractor may test the fiber optic cable prior to installation, but must test fiber optic cable after installation.
2. The Contractor shall test all fibers in the cable.
3. A continuity test using a power meter shall be used for 12 strand cables less than 200 feet. Power reading shall be provided with test results.
4. The Contractor shall use both a power meter test for continuity and an optical time domain reflectometer (OTDR) to test all other cable spans greater than 12 strands and longer than 200 feet. Proof of Calibration of all fiber optic test equipment may be requested by the inspector at any time, and must be provided along with the test results.
5. The fiber cable shall meet or exceed ANSI/EIA/TIA – 568B.3 and the latest BICSI TDM Standards.
6. Test Results shall include the following:
 - a. Total fiber length
 - b. Individual fiber traces for complete fiber length
 - c. Losses of all anomalies
 - d. Wavelength tested and measurement directions
 - e. Manufacturer, model number and serial number of test equipment
 - f. Name, signature and company technician/engineer
 - g. Test Equipment Calibration Certificate for all fiber test equipment
 - h. Test Date
7. The Contractor shall provide the test results to the City Inspector. If fiber cable fails to meet cable testing standards and are not approved by the City, the Contractor shall remove the failed fiber optic cable and replace with new fiber optic cable at no additional cost to the City. New fiber optic cable shall be tested according to cable testing requirements in these Special Provisions.

77-13 MASTARM STREETLIGHT

A. General

Mastarm streetlights standards, Type 15, and foundation shall be in accordance with the latest California Department of Transportation Standard Plans, unless otherwise specified in these Special Provisions and Plans. Remove concrete forms on poles upon project completion. Remove all plywood, forms, excess and leftover concrete, and other debris as a result from construction upon project completion.

B. Luminaire

Luminaires to be installed shall be specifically designed for LED use and rated for up to 100,000 hours of operation. Luminaires shall be designed to produce asymmetric distributions conforming to the Illuminating Engineering Society light pattern Type III unless otherwise specified. Luminaire shall utilize a heat sink to efficiently draw heat away from the LED chipset.

The units shall be suitable for two-inch (2") slip filter and mounting.

All new luminaires to be installed shall be inspected by the Engineer prior to installation. Luminaires shall be supplied without photo cell receptacles unless otherwise called for the Plans. All luminaires supplied with photo cell receptacles that will not be used shall be required to completely bypass the receptacle and a shorting plug shall be securely installed in the receptacle.

C. LED

The following luminaires are approved products for mastarm streetlights:

- EOI eLite Star SL3x-M LED Street light – model # ESU F A01 3M 032 40 M 700 (type 3 Distribution) - for general roadway lighting at 700ma.
- EOI eLite Star SL3x-M LED Street light – model # ESU F A01 3M 032 40 M 105 (type 3 Distribution) - for Traffic Signal Intersection lighting at 1050ma.

The luminaire shall be type III with a minimum CRI of 70 and a CCT of 4000K, unless otherwise specified.

77-14 ORNAMENTAL STREETLIGHT

A. Streetlight Assembly

The streetlight manufacturer shall provide all required components to assemble a streetlight as shown in the attached drawing and as described in the following Special Provisions. The manufacturer shall guarantee that all components provided, when assembled, shall constitute a complete functioning streetlight.

The streetlight capital, globe holder, light engine base, fluted shaft, and base shall be delivered as a single unit, fully assembled and painted as describe in the following Special Provisions. The luminaire assembly, Light Emitting Diode (LED) light engine, and anchor bolts, if required, may be delivered in a separate shipment or container.

Optionally, streetlight assembly shall have weatherproof UL listed GFI electrical receptacles mounted at the top of the pole shaft.

The complete streetlight assembly and anchor bolts shall be delivered to a location in the metropolitan area of Sacramento, California, as specified by the City. The City will provide the manufacturer the delivery destination within two weeks prior to the delivery date, unless otherwise specified by the City.

B. Luminaire Assembly

The luminaire assembly shall include a 424 Lexalite Acrylic Prismatic Top, GE8-9 globe, Formed Plastic FP 199, or National Lighting NL199 globe or approved equal as shown on the drawing. The luminaire assembly shall be UL listed for wet/damp locations and shall be furnished prewired.

The Lexalite 424 globe shall have IES Distribution Type III or V as specified by the City Engineer. Assembly of top and bottom parts of the globe shall be by a stainless steel band. Globe top shall not include a factory installed Lexalite spike aluminum finial. The globe shall be provided with a neck ring so that the tightening of the screws will not damage the globe collar.

Unless otherwise specified, the lamp assembly shall be delivered with a light engine. The light engine shall be of LED manufactured by CREE, model DPT A SB FR A 40K UL UF or approved equal. SB = represents surface face. FR = represents Frost Glass lens. A = represents 34W LED. 40K = represents 4000K. UF = represents unfinished.

<https://lighting.cree.com/products/outdoor/decorative-street-and-roadway/dpt-series>

C. Cast Iron Capital and Globe Holder

The capital and globe holder shall be of the design and dimensions as shown on the drawing and shall be of cast iron per ASTM A48 CL30 standards. The globe holder shall have four (4) 5/16" stainless steel set screws (90 degrees) for mounting of the globe. Set screws shall be square head. Allen or Phillips set screws are not acceptable. The capital shall be prewired with a light engine base. The light engine base shall be of porcelain mogul type. The capital shall be attached to a 4" tenon mounted on top of the steel fluted shaft with four (4) 5/16" stainless steel screws.

D. Steel Fluted Shaft

The fluted shaft shall be of the dimensions shown on the drawing and shall be tapered 0.14" per foot. The fluted shaft shall have the chemical and physical properties of A595 grade A. The fluted shaft shall be fabricated from a single length of a minimum 11-gauge steel sheet, rolled into a fluted shaft on a steel mandrill and finished with a single longitudinal weld. No transverse or intermediate welds or joints shall be permitted.

The fluted shaft shall have sixteen (16) equally spaced Doric flutes, sharp and clear-cut throughout the entire length of the shaft. The radius of the flute's crest shall not exceed the thickness of the shaft material. Individually rolled flutes or round poles with a separate fluted sheathing are not acceptable. Shaft shall be formed true to the pattern and complete in detail. The interior surface shall be smooth with no protrusions or sharp edges. There shall be a minimum of 2" internal clearance extending the fluted shaft's length to permit internal wiring from an underground source.

At the top of the fluted shaft, a steel tenon shall be welded and sized to accept the capital and globe holder. The maximum difference in the diameter of the capital and the tenon shall be 1/2".

A 1/2" steel adapter plate, of 36,000 psi minimum yield strength, shall be welded to the bottom of the fluted shaft. The adapter plate shall include three (3) tapped holes on a 4" bolt-circle to accept 1/2" -13 stainless steel bolts for attachment to the streetlight pole base. The stainless steel bolts shall be per ASTM F593. The bolts shall be with a minimum yield strength of 92,000 psi. The maximum diameter offset between the bottom of the fluted shaft and the adapter plate shall be as shown in the drawing.

All welds shall meet AWS D1.1.

The complete fluted shaft shall be hot-dipped galvanized per ASTM A123 prior to painting.

E. Cast Iron Base

The streetlight base shall be of the design and dimensions as shown on the drawing and shall be of cast iron per ASTM A48 CL30 standards with a minimum thickness of 1/2".

The base shall have an opening for the hand hole of the dimensions shown on the drawing with the cover cast of the same material, and attached with a 1/2" stainless steel, button head hex socket cap screw. The base shall have three (3) holes integrally cast into its top to be attached to the shaft. A minimum of 2" wiring access hole shall also be provided.

The base shall be furnished with a 12"-13 UNC grounding bolt.

The base shall have four (4) reinforced lugs integrally cast into its bottom to accept 3/4" anchor bolts on a 15" bolt-circle.

F. Anchor Bolts

Unless otherwise specified, each streetlight assembly shall include four (4) galvanized steel anchor bolts of the dimensions as shown on the drawing. Anchor bolts shall meet ASTM – A36 with 55,000 psi minimum yield strength. The threaded portion shall be galvanized. Each anchor bolt shall include two (2) galvanized hex nuts and two (2) flat washers. All galvanized parts shall meet ASTM A153.

G. Surface Coating

The exterior and interior surfaces of the streetlight base, fluted shaft, and capital shall have surface preparation, primer coating, and two coats of paint. The surfaces of the base, fluted shaft, and capital shall have a smooth finish that shall be uniform along the entire length of the streetlight pole assembly. All surface preparation, primer coating, and painting application shall be performed inside a shop or plant before shipment to jobsite.

The manufacturer shall provide Manufacturer Certification that all primer coating and paint application was performed per coating manufacturer specifications for the selected coating, prior to delivery of streetlight pole. Minor field coating touch-up may be permitted at the City's discretion.

All work shall be performed in strict accordance with these specifications and the manufacturer's directions for the materials to be used on this project.

1. Surface Preparation

The exterior and interior surfaces of the pole shall be prepared as follows:

- a) All sharp edges shall be removed or rounded.
- b) Contaminants such as oil, grease, dirt, etc., shall be removed by solvent cleaning per SSPC-SP1 (solvent cleaning).
- c) All non-galvanized surfaces shall be blasted per SSPC-SP10 (Near White Metal Blast) to remove all rust, mill scales, slags, and foreign matters.
- d) Streetlight base, fluted shaft, and capital shall be primed on the same day the surface preparation is completed.

2. Primer Coating

After surface preparation is completed, the cast iron streetlight assembly shall have a primer coating as follows:

- a) Use Sherwin Williams Macropoxy 646 Fast Cure Epoxy - Black (OR Mill White primer if Sacramento Green is specified as the paint color) or approved equal.
- b) Mix Macropoxy per manufacturer directions.
- c) Apply primer to the entire streetlight assembly, including the interior and exterior surfaces.
- d) Apply a fog coat of primer of 1.0 - 2.0 mills, approximately 1 hour prior to full prime coat.
- e) Apply full prime coat at the recommended spreading rate per coat for the Macropoxy 646 Primer; wet mills (7 minimum, 13.5 Maximum), dry Mills (5 minimum, 10.0 Maximum). See manufacturer product information for drying schedule and application conditions.

3. Paint Application

After primer coating, the streetlight assembly shall be painted as follows:

- a) Use Sherwin Williams Hi-Solids Polyurethane 100 - Gloss Black (OR Sacramento green color if specified on the drawing) or approved equal.
- b) Apply two (2) coats of paint to the entire streetlight assembly, including the interior and exterior surfaces.
- c) Apply the paint at the recommended film thickness and spreading rate per coat; wet mills 3.6 minimum, 4.8 maximum; dry mills 3.0 minimum, 4.0 maximum. See manufacturer product information for drying schedule and application conditions.

Paint application shall be in accordance with the principles of good workmanship described in SSPC-PA1, Paint Application Specification No. 1, Shop Field and Maintenance Painting. The Quality Control/Specifications are as follows: Dry Film test per ASTM D7378-07, Holiday Porosity Test per ASTM D5162-01, Cross Hatch Adhesion per ASTM D6677-01, Pencil Hardness test per ASTM D3363, Impact Resistance per ASTM D2794, Visual Gloss Inspection, and Final Visual Inspection.

H. Design Standards

Streetlight assembly and all materials used in its manufacture shall meet the requirements of the most current adopted version of the American Association of State Highway and Transportation Officials (AASHTO) "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and this specification.

In addition to the requirements of the AASHTO Specification, the post and anchorage shall be designed with a minimum safety factor of two (2) and shall not deflect more than five (5%) percent of the above ground height at full wind loading.

I. Factory Certification

Each streetlight assembly shall be certified by the manufacturer to meet all requirements specified herein. The manufacturer shall make factory and all manufacturing processes open for City Quality Control Inspection if requested by the City Engineer. City shall incur all inspection cost.

J. Identification

Each pole shall bear an identification tag which shall list the manufacturer model number of the pole and year and location of manufacture. The identification tag shall be placed inside of the base, facing the hand hole, and clearly visible from the outside when installed and the hand hole cover is removed.

K. Material Availability

Pole manufacturer shall certify to the City that the accepted pole base, capital, shaft, and luminaire is or will become a stock item, readily available with replacement parts for a minimum ten (10) year.

L. Material Certification

Material certifications shall be provided for all components referred to in the drawing and these Special Provisions.

M. Packaging

Each streetlight assembly and luminaire shall be individually packaged to prevent damage with sufficient packaging strength for protection during shipping and storage. Small parts shall be packaged in boxes. Individual components shall be packaged in the same manner as the poles and luminaires. All handling shall be done with rope or nylon slings to prevent surface damage. Use of chains, wire slings or unprotected forks or hooks is prohibited.

Packing list and assembly instruction sheet shall be included.

N. Acceptance

After packaging is removed and prior to installation, each streetlight assembly shall be inspected for manufacturing or paint defects by the City Engineer. No streetlight assembly is to be installed without the expressed approval of the City.

O. Testing

Factory testing shall be provided at the request of the City Engineer in accordance with manufacturer's testing procedures.

P. Warranty

The streetlight manufacturer shall warrant against any defects and shall replace all defective parts or streetlight assemblies for a period of five (5) years from the date received by the City. Pole manufacturer shall provide written warranty with shipment of poles.

Q. Welding

Welding shall be conducted by certified welders in compliance with the latest edition of the American Welding Society D1.1, Structural Welding Code - Steel. All parts shall be cleaned prior to welding by an approved industry standard method.

R. Wind Resistance

Entire pole and luminaire to be rated to withstand AASHTO requirements for a minimum 70 mile and hour wind load with a 30% gust factor.

S. Sealing of Streetlight Pole Foundation

The concrete for the foundation shall be finished so that the top surface is straight and smooth with a 2% grade conforming to the adjoining sidewalk.

Remove concrete forms on streetlight foundation upon project completion. Remove all plywood, forms, excess and leftover concrete, and other debris as a result from construction upon project completion.

Once the pole is installed and leveled on the anchor bolts, the gap between the base of the pole and the top of the foundation shall be sealed using the following procedure:

The bottom surface of the pole base shall be primed using Pecora P-120 or approved equal and the top of the foundation shall be primed using a Pecora P-150 or approved equal. The curing of the concrete used for the foundation or pavement and the application of the primer shall follow the guidelines provided by the manufacturer of the primer and sealant.

The gap to be sealed shall be partially filled by pushing in a 1.5" diameter Bi-Cellular Backer Rod (SOF Rod), cut to size, and installed around the bottom perimeter of the pole base, pushed against the anchor bolts. The backer rod product shall be made by Construction Foam Products or approved equal.

A one half-inch (1/2") inside diameter drain tube shall be placed in the gap between the base of the pole and its foundation to prevent standing water. The drain tube shall be placed under the backer rod, flush with the finished surface of the concrete, and extending about 2.25" toward the center of the pole base. It shall be placed so that it is following the downward slope of the surrounding sidewalk and top of foundation (about 2%). The drain tube shall be made of PVC with a wall thickness of 1/16" or as approved by the engineer.

Once the primer is dry as recommended by the manufacturer, and the backer rod is installed, the Contractor shall apply a silicone sealant, with a minimum thickness of 0.5 inch. Use a pre-tinted black color silicone, model number Pecora 890NST or approved equal. Completely seal the gap between the base of the pole and the top of the foundation with the silicone sealant. Use a masking tape when applying the sealant, in order not to smear the outside of the pole, and the surrounding pavement with the sealant material. The sealant shall be smoothed out around the base of the pole, and any excess material removed before it is set to cure as required by the sealant manufacturer.

77-15 PULL BOXES

Shall be in accordance with Section 34-12 of the Standard Specifications, except for the following:

- a. All new pull boxes shall be set in place prior to pouring any new sidewalk.
- b. Existing pull boxes damaged by the installation of new conduits shall be removed and replaced at the Contractor's expense as directed by the Engineer.
- c. All pull boxes shall be placed in sidewalk areas unless otherwise specified on the plans or directed by the Engineer, and shall not be placed in driveways, in vehicular traveled lanes, or in any part of the new sidewalk handicap ramp areas. Unless otherwise specified, pull boxes shall be placed a minimum of 5 feet from existing driveways.
- d. Contractor shall cut, remove and replace the concrete to the nearest joint when installing new pull boxes.
- e. New pull boxes shall have a minimum of 6" of new concrete around all sides in sidewalks.
- f. For pull boxes to be removed, holes or depressions resulting from the removed pull box shall be filled, compacted, brought to grade, and filled to match surrounding materials.
- g. Pull boxes shall be placed as shown according to the details shown on the Plans and according to these Special Provisions.
- h. Install pull box on top of crushed rock foundation. Adjust pull box to grade. The crushed rock foundation shall have a minimum of 12" in depth and continue to extend a minimum of 6" beyond the outside edge of the pull box. Compact crushed rock while maintaining integrity of conduit. Conduit and pull boxes shall not be damaged nor cracked.

- i. In instances where the pull box is installed in a planter box or dirt areas, the pull box shall be set to grade with a concrete ring, as shown in the standard detail drawings.

Locking Pull Box Security Lids for Street Lighting

1. No locking Security Lids shall be use on Pull Boxes containing traffic signal wiring.
2. All No. 5 and No. 6 Pull Boxes containing street light wiring shall have steel security lids with locking key bolts.
3. Security Bolts shall be Bryce Fastener #50 Penta-Plus approved equal.
4. Security Keys shall be Bryce Fastener 1GBP50 or approved equal.
5. Lid shall be ¼" thick minimum galvanized steel.
6. Lid shall be manufactured with slip resistant surface.
7. Lid shall be non-traffic rated, unless otherwise specified.
8. Lid shall be equipped with a lock mechanism which can be secured from the top of lid.
9. Lock bolt shall be recessed in 1 inch diameter circle
10. Lid shall be flush with top of pull box when the lid is completely secured and locked to the pull box.
11. No. 5 pull boxes shall have a single cam locking system, or approved equal.
12. No. 6 pull boxes shall have a double cam locking system, or approved equal.
13. Lid shall have a grounding lug.
14. Supply five sets of keys for the locks.
15. Supply two sets of lifting tools for the lid.
16. Lid shall be free of scratches, defects, and debris. Provided Lids shall be installed new.
17. Pull Box Lid shall be manufactured by LockLid Secure Utility Enclosure Lids manufactured by Jensen MetalTech or approved equal. Approved equal includes Sipra Corp and Wesco Mr Steel.
 - o #5 PB - Locklid 1324 Lid LL K-S TrxPlt Sac Glv;
 - o #6 PB – LockLid 1730 Lid LL K-SD TrxPlt Sac Glv).
 - o #5 PB Sipra Corp's Lockjaw! Security lids
 - o #6 PB Sipra Corp's Lockjaw! Security lids
 - o #5 PB WESCO's Mr. Steel Security lids
 - o #6 PB WESCO's Mr. Steel Security lids
18. A steel welding plug shall be provided by the manufacturer to be inserted into the 1 inch diameter recessed lock

77-16 TRAFFIC SIGNALS AND FITTINGS

Traffic Signal Standards and Lighting Standards shall be in accordance with the latest California Department of Transportation Standard Plans, unless otherwise specified in these Specifications or Plans.

- A. Forms and Concrete and Debris

Remove concrete forms on traffic signal standards and service pedestals upon project completion. Remove all plywood, forms, excess and leftover concrete, and other debris as a result from construction upon project completion.

B. Vehicle Signals

All signal heads, louvers, backplates, and framework shall come in black color.

Each mast arm mounted signal head shall be all 12" diameter sections.

Vehicle signal housings shall be either die cast or permanent mold cast aluminum conforming to ANSI Standard D 10.1. Vehicle signal faces shall conform to Section 86 4.01, "Vehicle Signal Faces", of the State Standard Specifications.

Metal backplates shall have a 2-inch yellow retroreflective boarder for the 12" signal heads. The retroreflective tape shall be manufactured by 3M for vertical mounting. Model: 3M 3990 Series Diamond Grade VIP Reflective Sheeting.

Metal Backplate shall be louvered and painted black.

Traffic signals shall utilize tunnel visors.

All traffic signal lamps shall be accessible from the front of the traffic signal head and shall be directly accessible for removal and replacement by the opening of the hinged front lens section and hood. Backplates for MAS mounted vehicle signal heads shall have approved filler plates to prevent light from showing through at the elevated plumbizers.

C. Light Emitting Diode (LED) Signal Modules

LED modules shall be 12" in diameter, clear lens, and manufactured by Dialight, Leotek, Duralite, or EOI. No exceptions.

LEDs shall have full ball appearance.

Front shell shall be Clear, not Tinted.

Contractor shall warranty the LED module for a minimum of 3 years. Contractor is responsible to immediately replace the failed LED module at no cost to the City during the warranty period of 3 years.

D. LED Countdown Pedestrian Signals

LED modules shall be manufactured by Dialight, Leotek, Duralite, or EOI. No exceptions.

All pedestrian display shall be the combination Raised Hand/Walking Person figure and Countdown timer only. All pedestrian heads and framework shall come in black color.

Pedestrian signal face modules shall be designed to mount behind or replace the existing faceplate of Type A Pedestrian housings as specified by the requirements of the ITE Standards, "Pedestrian Traffic Control Signal Indications", and the MUTCD. The pedestrian signal shall have an operating range of 80VAC to 135VAC. The pedestrian signal shall be fused and provide transient suppression for protection of line and load. The pedestrian signal shall have a high power factor > 0.9. The pedestrian signal shall have < 20% harmonic distortion.

The design of the modules shall require a specific mounting orientation. Each module shall provide an average luminous intensity of at least 3,750 candela/m² for Upraised hand and 5,300 candela/m² for the Walking person symbol throughout the useful life over the operating temperature range.

The uniformity ratio of an illuminated symbol shall not exceed 4 to 1 between the highest luminance area and the lowest luminance area in the module.

The color output of the module shall conform to the requirements of the ITE: "Pedestrian Traffic Control Signal Indications" and the MUTCD.

The Hand Man symbols shall conform to all applicable ITE and CalTrans requirements. Raised Hand shall be Portland orange. Walking figure shall be lunar white. The module shall not require special tools for installation. The module shall fit securely into existing pedestrian signal section housings built to the PTCSH specifications without modification to the housing.

The pedestrian signal face shall be no less than 16" high. Aluminum housing.

The modules shall be a self-contained device, not requiring on-site assembly for installation into an existing Type "A" housing. The pedestrian signal shall be capable of displaying the LED "Raised Hand" legend. The numeral portion shall consist of two (2) seven segment digits, constructed of a minimum of 2 rows of LED's, simultaneously. The pedestrian signal shall use overlays to diffuse the LED's and provide uniform light dispersion while keeping the symbols clear and distinct. The signal shall be configurable, such that the countdown timer can start at the beginning or the end of the "Walk" portion of the pedestrian phase. Initially, the Contractor shall set the signal such that the Countdown timer starts at the beginning of the flashing "Don't Walk/Raised Hand" portion of the phase and ends at the beginning of the solid "Don't Walk/Raised Hand" portion of the phase.

Modules shall have filled hand/man.

E. Mounting Hardware

All slipfitters and terminal compartments shall be cast bronze. Clam shell mounting assemblies shall not be used.

No gaskets shall be used between the slipfitter and the traffic signal display. Seal connection with silicone gel.

F. Pedestrian Pushbuttons (ADA- Compliant)

The Polara Bulldog is an acceptable Pedestrian Push Button assembly.

Unless otherwise specified, pedestrian pushbuttons shall comply with the following features:

1. ADA-compliant pedestrian pushbutton, per applicable sections of the Cal MUTCD and United States Access Board recommendations.
2. Size of Button. The push buttons shall be a minimum of 2 inches (51mm) across.
3. Maximum Force. The force required to activate the push buttons shall be no greater than 3.5 pounds.
4. Operation. Push buttons shall operable with a closed fist.
5. Locator Tone. Locator tone shall be provided if specified by the Plans and these Specifications.
6. Visual contrast. Push buttons shall have a visual contrast with the body background of at least 70 percent.
7. Indicator. There shall be a visible and audible indicator that the button press has occurred.
8. Tactile arrow. There shall be a tactile arrow pointing in the direction of pedestrian travel controlled by the button.
9. Mounting Height. The centerline of the push button shall be mounted 42 inches above the clear ground space for approach.
10. Direction of control face. The control face of the push button shall be parallel to the direction of the crosswalk controlled by the push button.

The pedestrian button shall be heavy cast aluminum, powder-coated body and meet NEMA 250 specifications, tamper-proof design, and water resistant. The button cap and internal components shall be constructed with stainless steel components to prevent corrosion. Button shall provide a two-tone audible confirmation and visual confirmation (LED light). Wide operating temperature range of -30 degrees to 165 degrees F. Button shall require push action to activate.

G. Accessible Pedestrian Signal (APS)

If specified in the Plans, the Accessible Pedestrian Signal (APS) shall be manufactured by Polara Engineering Inc.

- Pushbutton Model: Polara, 2-wire iDS29UB1-Y with iDetect.
- Control Unit: iCCU-S for TS1, TS2 cabinets.
- Control Unit: iCCU-C for 332 cabinets/2070 controller
- Interconnect Board: iN2-ICB for iCCU-S.
- Interconnect Board: iN2-ICB-C for iCCU-C
- Size of Sign: 9x12. Use R10-3B(CA) sign and braille on faceplate.
- Housing Color: Yellow button cover.
- Special Voice Message for Wait to Cross Street Name and Walk Sign is On to cross Street Name.
- No Braille.
- SDLC for TS2 Type 1 cabinets. 850-217 (50 pin harness) for TS 1 cabinets.

The main components of the MUTCD compliant APS consists of a 1) Push Button station that is installed on the traffic signal poles providing a vibrating arrow button and audible sounds , and 2) Control Unit that is installed in the traffic signal cabinet. All sounds emanate from the front and back of the push button. A sunlight-visible red LED toggles to "ON" with tactile feedback to confirm the button has been pushed. Vandal resistant designed body and pushbutton.

APS shall be installed in accordance with the City of Sacramento's APS Implementation Guidelines.

1. Push Button Station:

- a. A Push Button Station receives pedestrian crossing requests and provides visual, audio, and speech pedestrian messages to aid street crossing. The Push Button Station shall be installed per the latest requirements of the California MUTCD. The pushbutton shall be constructed of cast aluminum or equal, painted with yellow background, black crossing logo, a tactile arrow indicating the direction of crossing it services, and an integrated two-inch diameter pushbutton. When the pushbutton is activated, the pushbutton shall confirm each activation by visual, audio, and vibrotactile feedback.
- b. Audio messages shall be via integrated, sealed, and weatherproof speakers capable of emitting locator tone and speech messages. Audio output shall be up to 10 watts RMS. Each audio output shall have an automatic volume control up to 28dB. There shall be independent maximum and minimum volume settings for locator, walk, and clearance. Audible locator tone shall be at 880 Hz, 100 msec duration, 1 sec interval. Each pushbutton activation shall cause an audible click. An extended activation on any pushbutton shall mute the entire intersection except selected crosswalk. All audible tones and sounds shall be synchronized to minimize confusion and audio clutter.
- c. Vibrotactile shall be integrated into the pushbutton and shall be energized during the WALK interval.
- d. The pushbutton shall be speech message capable. When activated, speech message volume shall be adjustable up to a maximum of 89 dB and up to 5 dB above the ambient noise measured at the pushbutton level. Speech messages shall include programmable pushbutton and crossing messages. Pushbutton message shall be, "Wait to cross (name of street) at (name of other street.)" Crossing message shall be, "(Name of street.) Walk signal is on to cross (name of street.)" For exclusive pedestrian phases, the crossing message shall be, "Walk signal is on for all crossings." Speech messages shall repeat at the rate of 1 hertz from the beginning of the appropriate phase to the end of the phase.
- e. The pushbutton shall operate in temperatures between -20 to +150 degrees

2. Control Unit:

A Control Unit (CU) provides the interface between the traffic signal controller and PIUs. It passes through pedestrian crossing requests from PIUs to the controller while relaying WALK and clearance timing from the controller to PIUs. The CU shall be a shelf-mounted or rack-mounted unit compatible with TS1, TS2, and Type 2070 controllers housed in Type R or 332 -series cabinets. Each CU shall be able to control up to 12 PIUs. The CU shall interface with the controller and PIUs via optically isolated input/output up to 36 volts. The CU shall maintain system settings and diagnostic data retrievable by the System Programmer described below. The CU shall operate in temperatures between -20 to +150 degrees F.

H. Traffic Signal Standards

All mounting hardware to be furnished by the Contractor shall be galvanized.

77-17 TRAFFIC SIGNAL TURN-ON PROCESS

The traffic signal turn-on process is located at the following location in the category of "Traffic Signals and Streetlighting":

<https://www.cityofsacramento.org/Utilities/Development-Standards>

77-18 VIDEO DETECTION SYSTEM - ECONOLITE VISION

In general, the video detection system shall provide real time detection of vehicles, bicycles and motorcycles entering the camera's field of view with an accuracy of 99% minimum, when compared to conventional inductive loops. The detection shall be reliable, consistent, and perform under all weather, lighting, and traffic congestion conditions. The video detection system consists of video sensors, a communication interface panel, mounting brackets and cabling hardware. For 33X cabinet with Model 2070 controller, the video detection system will include an input/output card mounted in the input file.

Video Detection System Hardware

In general, the video detection system shall provide real time detection of vehicles, bicycles and motorcycles entering the camera's field of view with an accuracy of 99% minimum, when compared to conventional inductive loops. The detection shall be reliable, consistent, and perform under all weather, lighting, and traffic congestion conditions. The video detection system consists of video sensors, a communication interface panel, mounting brackets and cabling hardware. For 33X cabinet with Model 2070 controller, the video detection system will include an input/output card mounted in the input file.

Video Detection System Hardware

The video detection system shall be an Econolite Autoscope Vision or approved equal.

Video Sensor

The video detection system shall include a video sensor that integrates a high-definition (HD) camera with an embedded processor for analyzing the video and performing detection.

Camera and Processor

The camera shall be a color CMOS imaging array.

The camera shall have HD resolution of 720p minimum (1280x720 pixels).

The camera shall include a minimum 10X optical zoom to enable stop-line and advance detections. The optical zoom shall be remotely controllable from the TMC for temporary traffic surveillance as well as for maintenance purposes.

The camera shall have direct, real-time iris and shutter speed control by the integrated processor.

The processor shall support H.264 video compression for streaming output.

Video Sensor Enclosure Assembly

The camera and processor shall be housed in a sealed IP-67 enclosure.

The faceplate of the enclosure shall be glass and shall have hydrophilic coating on the exterior surface to reduce debris accumulation and maintenance.

The faceplate shall have a thermostatically-controlled indium tin oxide (ITO) heater applied directly on the interior surface to keep the faceplate clear of condensation, snow, ice and frost.

An adjustable aluminum visor shall shield the faceplate from the sun and extraneous light sources. The visor shall not interfere with the full 360° field of view.

An integral aiming sight shall assist in aiming the camera for the detection objectives.

A removable rear cap and cable strain relief shall seal the power connection.

The rear cap shall be tethered to the enclosure to avoid dropping the cap during installation.

The rear cap shall be fastened to the body of the video sensor with a single, captive bolt.

The rear cap and enclosure shall include Gore breathers to equalize internal and external pressure.

The sensor shall be self-supporting on manufacturer's mounting brackets for ease of installation.

Power and Communications

Power and communications for the video sensor shall be carried over a single three-conductor cable of 18 AWG minimum and with a polyethylene jacket. The cable shall be of sufficient length and slag.

Termination of the three-conductor cable shall be inside the rear cap of the enclosure on a three-position, removable Phoenix terminal block. Each conductor shall be attached to the Phoenix plug via a screw connection.

The video sensor shall operate over an input voltage range of 89 to 265 VAC at 50 or 60 Hz.

Power consumption shall be no more than 16 watts maximum including heater.

No supplemental surge suppression shall be required outside the cabinet.

All communications to the video sensor shall be broadband-over-power via the same three-conductor cable that powers the unit. Coaxial cable shall not be required.

Communications Interface Panel

The video detection system shall include an interface panel in the traffic cabinet that manages communications between the video sensors, the traffic management center, a maintenance technician, and the traffic cabinet itself.

Video Sensor Connection

The communications interface panel shall provide connection points for four video sensors.

Each sensor connection shall be a 3-pole terminal block, which supplies power and broadband-over-power communications to the sensor.

The broadband-over-power communications shall provide a throughput of 70 to 90 Mbps.

The broadband-over-power connection shall support at least 1,000 feet of cabling to the video sensor.

Each video sensor connection shall include a power switch.

There shall be an LED for each video sensor to indicate the state of the power to the sensor and an LED for each video sensor to indicate the status of communications.

Each video sensor connection shall contain a resettable fuse.

Each video sensor connection shall provide high-energy transient protection.

Traffic Operation Center (TOC) Communications

An Ethernet port shall be provided to connect to a TOC.

The TOC connection shall support 10/100/1000 Mbps Ethernet communication.

The communications interface panel shall proxy all network requests that arrive on the TOC connection to avoid unwanted network traffic from reaching the broadband-over-power network between the communications interface panel and the video sensors.

All communications to the video detection system through the TOC connection shall be to a single IP address.

Local User Communications

A wired Ethernet port shall be provided to connect the user at the cabinet to the video detection system for setup and maintenance purposes.

The maintenance port shall support 10/100/1000 Mbps Ethernet communication.

All communications to the video detection system through the maintenance port shall be to a single IP address.

The maintenance port shall support DHCP to automatically assign an IP address to the user's computer, if desired.

An 802.11g Wi-Fi access point shall allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes.

All communications to the video detection system through the Wi-Fi access point shall be to a single IP Address.

The Wi-Fi access point shall support DHCP to automatically assign an IP Address to the user's computer.

The Wi-Fi access point shall include a dipole, omnidirectional antenna.

A momentary pushbutton shall allow the user to turn the Wi-Fi access point on or off.

The Wi-Fi access point shall turn itself off automatically after a period of inactivity from connected devices.

An LED shall indicate when the Wi-Fi access point is enabled.

The Wi-Fi access point shall operate simultaneously with the wired maintenance port and with the TMC connection.

Traffic Controller Connection

The communications interface panel shall provide one connection to communicate to the traffic controller through the cabinet.

The traffic controller connection shall support a TS2 Type 1 compatible SDLC interface.

The traffic controller connector shall be a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable.

The traffic controller connection shall support a protocol interface to SDLC-capable traffic controllers (NEMA or TEES).

The traffic controller connection shall support the NEMA TS2 SDLC protocol to include up to 64 detector outputs and 32 inputs.

The traffic controller connection shall be able to connect to a wired input/output card, which supports wired I/O in cabinets without a SDLC-capable controller.

The wired I/O data communications link shall support at least 24 outputs and 16 inputs.

SDLC communications and the input/output card communication shall be able to operate simultaneously.

USB Ports

The communications interface panel shall include two USB 2.0 ports to allow system and application software installation via portable media without removing the communication interface panel from the cabinet.

Power

The communications interface panel shall accept input voltage in the range of 89-265 VAC, 50/60 Hz power from the transient-protected side of the cabinet.

The communications interface panel shall be protected by two slow-blow fuses. Two spares shall be attached to the panel.

Input/Output Card

The video detection system shall support an input/output card that communicates with the communications interface panel for real-time detection states and other I/O to the traffic controller. The card may reside in a standard detector rack or shelf-mount enclosure with power module.

The input/output card shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES Input File.

The card shall occupy two slots of the detector rack.

The card shall provide four detector outputs on its rear-edge connector.

A front connector shall provide communication to the communications interface panel.

A front connector shall allow 16 inputs and 24 contact-closure detector outputs for wiring into the cabinet.

A front panel LED for each of the 16 inputs and 24 outputs shall indicate the state of the input or output.

The wired input/output card shall support optional expansion cards in other slots. Each expansion card shall support 4 outputs to the back edge of the card.

The input/output card shall support optional harnesses for connection to Input Files or C1, C4, C11, and C12 ports to support Type 170 or Type 2070 controllers.

System Software

The video detection system shall include management software for configuration, monitoring and data collection purposes.

Management Software

Management software shall be a Windows-based application.

The software shall be compatible with Windows 7 and Windows 10 operating systems or their later versions.

The software shall communicate with the video detection system via Ethernet.

The management software shall automatically determine all video sensors and communications interface panels available on the local network and populate a list of all devices.

The management software shall provide the user a means to name individual video sensors and communications interface panels.

The management software shall provide a means for the user to zoom the camera optics while viewing a live video stream.

The management software shall provide a means for the user to calibrate distances in the field of view.

The management software shall provide the user a means to create 4-sided detection zones in the field of view using either a still snapshot or live video.

The management software will overlay an outline of each detection zone over the background image.

The management software shall enable the user to:

- place detection zones anywhere in the field of view for stop line detection and/or advance detection.
- set the desired color of both the on and off states of the detection zone overlay.
- alter the size and shape of any previously created zone.
- overlap zones, either partially or fully.
- name each zone uniquely.
- assign each zone to detect vehicles, to detect bicycles, or to detect both, and to specify different outputs for each type.
- assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.
- assign a single zone to more than one output such that if a vehicle or bicycle is detected, all the assigned outputs shall be turned on.
- create at least 99 detection zones per video sensor.
- retrieve all configuration parameters from video sensors or communications interface panels.
- save all the settings for a video sensor or a communications interface panel to a laptop file.
- read or import all the settings from a previously saved configuration file for a video sensor or a communications interface panel.
- download a new version of the application software into a communications interface panel and its attached video sensors.
- monitor operation of a video sensor.
- The monitoring screen shall include a live video stream from the video sensor with at least HD 1280x720 pixel resolution.
- The monitoring screen shall show indications of detection in real time by changing the color of the detection zone.
- configure different indications for vehicle detections vs. bicycle detections when both are configured for the same zone.
- size and position the following objects anywhere on the screen and to change the color and size of text.
- An indication of when an output is on or off, along with a user-configurable name for that indicator.
- The current time in the video sensor.
- A user-configurable title or name.
- The version number of the video sensor software.
- turn the overlay graphics on or off with a single setting.

The management software shall provide a screen to monitor operation of the intersection with a quad-view video stream from the communications interface panel. The quad-view video stream shall have a resolution of at least HD 1280x720 pixels, where each of the sensor videos comprising the quad-view shall be at least 640x360 pixels.

The user shall be able to configure the order that the sensor videos appear in the quad-view.

The real-time quad-view video stream shall be capable of displaying the overlay graphics for all four sensors simultaneously.

While monitoring the video of a single video sensor or of the quad-view, the user shall be able to request a "snapshot" or single-frame image to save to a named file on a laptop.

While monitoring the video of a single video sensor or of the quad-view, the user shall be able to record a period of the video to save to a named file on a laptop.

System Functionality

Detection Performance

The video detection system shall detect the presence of vehicles in defined zones and turn on the assigned output when the vehicle is present in the zone.

Stop Line Detection

Stop-line detection accuracy shall be 99% minimum.

False-positive stop-line detection shall be 3% maximum.

Advance Detection

Advance detection zone shall be a minimum of 600' from the video sensor. The video sensor's field of view shall extend a minimum of 30' beyond the advance detection zone.

Accuracy data shall be collected over 24-hour time intervals to avoid a single lighting condition, and a minimum of one hundred (100) vehicles per lane. The calculations of detection performance will not include turning movements where vehicles do not pass through the detectors, vehicle lane-change anomalies, or where they stop short or stop beyond the combined detection zones.

Failsafe Mode

The video detection system shall provide a failsafe mode for each video sensor. If the failsafe mode is enabled, all programmed presence detection outputs for the video sensor shall be turned on, thus placing constant calls to the controller. When failsafe mode is disabled, all outputs revert to normal on/off operations.

The video sensor shall continuously monitor the overall contrast in the video. If the overall contrast falls below a preset level (such as caused by dirty faceplate, severe glare, extreme fog, or temporary ice/snow on the faceplate), the sensor shall enable the failsafe mode. When sufficient contrast is restored in the video, the sensor will disable the failsafe mode.

The communications interface panel shall continuously monitor the connectivity status of the attached video sensors. If any video sensor goes offline due to either electrical failure or internal software failure, the communications interface panel shall enable the failsafe mode for that video sensor. If the video sensor comes back online, failsafe mode shall be disabled.

Data Collection

The video detection system shall automatically collect and store traffic flow data in non-volatile memory for later retrieval and analysis. No additional hardware or software shall be necessary. The data shall include:

Vehicle counts.

Vehicle average speeds.

The management software shall be able to retrieve collected data for a specified period of time or for all currently stored data and save into a standard CSV file.

Operations Log

The communications interface panel and each video sensor shall maintain a time-stamped operations log of routine and special events in non-volatile memory for later retrieval and analysis.

Time Synchronization

The video detection system and management software shall provide three methods to synchronize the time of day clocks in the communication interface panel and the video sensors, as follows:

Manual time synchronization operation by the user, which sets the time to the current time on the laptop where the management software is running.

A configuration setting to allow the communications interface panel to automatically obtain time from the NEMA TS2 protocol on the SDLC channel and broadcast it to the video sensors.

A configuration setting to allow the communications interface panel to automatically obtain time from up to five Network Time Protocol (NTP) sources and broadcast it to the video sensors.

Video Streaming

In addition to the ability to view video streams in the management software, the user shall be able to view video from individual sensors or to view the quad-view from the communications interface panel using a third-party video player application on a tablet, smartphone or laptop computer.

Video Detection System Hardware

Equipment shall be an Econolite Autoscope Vision, or City Traffic Engineer approved equivalent prior to submitting bid.

	Qty	Hardware
Per Leg	1	Autoscope Vision (AVISION) white
	1	Mounting Brackets (34238G24) – 28"
	FT	Econolite 3-wire only cable, 18 AWG, Polyethylene jacket Model 1175-010 for 500 feet. Model 1175-011 for 1000 feet.
Per Intersection	1	Autoscope Vision Comm Manager (AVCM)
	1	SDLC cable Model 33550G5 for Econolite ASC2/ASC3 OR McCain ATC EX NEMA (for majority of City of Sacramento configurations). Model 33550G3 for TS2 Cabinet with SDLC Hub 15 pin to 15 pin Model 33550G8 for TS1 Cabinet with 2070 Model 33274G2 for TS2 Cabinet without an SDLC Hub
	1	Ethernet Cable RJ-45 connectors. (200-1020-501)
		Three (3) years System warranty from of date of acceptance

For cabinets without SDLC hub or connections, a Vision I/O 24 Module shall be installed.

For Type R cabinet, the Autoscope Vision Comm Manager (AVCM) shall be mounted on a DIN rail attached to aluminum stock for support on the right side of the cabinet. The DIN rail and aluminum stock shall be mounted

to the cabinet channel rails. The Contractor is responsible for making all connections per manufacturer recommendations.

Installation

Camera shall be placed to minimize occlusions of left turn lanes. Occlusions can be minimized by installing the camera on the signal mast arm, in line with the lane striping between the left turn lane and the through lanes. Cameras installed on signal mast arm shall use Econolite 28" extended camera mount. At intersections where the left and through movements go together as standard operation and lefts are not intended to turn separately, the camera can be mounted on a luminaire arm with standard camera mounting bracket.

Camera shall be aimed so that the area of detection is in the top half of the video image. The farthest edge of the detector shall be at the top of the image, and at least four (4) cars shall be visible behind the stop bar, in the top half of the video image. No horizon shall be allowed in the video image.

Video detection system installed in traffic signal cabinets with network switches installed or scheduled to be installed shall use NEMA TS2 connections to controller. Contractor shall work with the Econolite Representative and the City of Sacramento Traffic Signal Maintenance Shop to ensure that all channels are programmed and detection calls are being received by the controller.

Video detection system installed in traffic signal cabinets without network switches installed shall use NEMA TS1 and logic level connections to controller. Contractor shall work with the Econolite Representative and the City of Sacramento Traffic Signal Maintenance Shop to ensure that all channels are programmed and detection calls are being inputted into the controller.

All penetration through signal poles or mastarms shall use Hayco Liquid \Tight Cordgrips or approved equal.

Software and Programming

An Econolite Representative shall be onsite for the installation and configuration of the Video Detection System at no additional cost to the City. The system shall be programmed to provide stop bar detection. All channels shall be configured per the City's detector programming sheet and the Contractor and Econolite Representative shall work with City of Sacramento Traffic Signal Maintenance Shop to insure the detection calls are being inputted into the controller.

General Aiming and Programming Notes for Video Detection

1. No horizon shall be allowed in video.
2. Camera shall be aimed such that the farthest edge of the detector is at the top of the image. Four to Five cars shall be visible between the stop bar and the top of the video image.
3. The Camera shall be rotated so the stop bar is horizontal in the video image.
4. Detection Zone shall be approximately 65' long or 2 cars.
5. Maximum detectable width is 6 lanes and bike lane.
6. Detector labels shall include assigned phase number and assigned channel number.
7. The phase status shall be displayed.

Technical Support & Warranty

1. All hardware associated with the video detection system shall be warranted for a minimum of three years.
2. The vendor shall provide all firmware and software upgrades to the City of Sacramento free of charge during the warranty period of the product.
3. Technical support shall be free of charge during the warranty period of the product.
4. Vendor shall provide 24/7 technical support.

5. Vendor shall provide training in the operation, setup, and maintenance of the video detection system, at no additional cost to the city.

77-19 WIRING

Wiring shall be in accordance with Section 34 15 of the Standard Specifications, except for the following:

1. After taping, all splices shall be painted with an approved electrical coating that will resist oil, acids, alkalies, and adverse environmental conditions.
 - 1.1. Pull ropes used to pull conductors in conduit shall be a minimum of three-eighths inch (3/8") in diameter.

77-20 CITY OF WEST SACRAMENTO DRAINAGE FACILITIES

77-20.01 GENERAL

Section 77-20 includes specifications for constructing City of West Sacramento drainage facilities.

City of West Sacramento drainage facilities include:

1. Curb Inlet and Catch Basin (Standard Detail No. 301)
2. Storm Drain Manhole (Standard Detail No. 302)
3. Storm Drain Junction Box (Standard Detail No. 305)
4. Storm Drain Marker (Standard Detail No. 306)
5. Storm Drain Pipes

77-20.02 MATERIALS

Unless otherwise shown on the plans, drainage facilities must comply with section 13 of the City of West Sacramento Standard Specifications.

77-20.03 CONSTRUCTION

Unless otherwise shown on the plans, excavation for drainage facilities must comply with section 12 of the City of West Sacramento Standard Specifications.

Curb and gutter reconstruction shall match existing geometry and, at the Engineers discretion, extend up to 5 feet in length on either side of the inlet. The cost of curb and gutter reconstruction shall be included in the unit price for this item. Surface restoration shall be in accordance with the appropriate section of these Special Provisions. Pavement cutting shall be perpendicular and parallel to the centerline of the road. Surface restoration due to drain inlet removal and installation shall be paid for as part of this item. Gutter depressions, as shown on the plans, shall be fully compensated into the unit price paid per drop inlet and no additional compensation will be allowed.

77-20.04 PAYMENT

Not Used

77-21 CITY OF WEST SACRAMENTO WATER FACILITIES

77-21.01 GENERAL

Section 77-21 includes specification for constructing City of West Sacramento water main facilities.

The City of West Sacramento water main work includes:

1. Installing new water main
2. Remove or abandon existing water main facilities
3. 2" Air and Vacuum Release Valve (Standard Detail No. 510)
4. Install new fire hydrant assemblies (Standard Detail No. 515)
5. Remove and salvage existing fire hydrant assemblies

Submit the following:

1. Shop Drawings
2. Product Data
3. Manufacturer's technical data showing complete information on material composition, physical properties, and dimensions of new pipe and fittings
4. Certificates of compliance for materials used

Water main testing must comply with Sections 2 and 15 of the City of West Sacramento Standard Specifications.

77-21.02 MATERIALS

Unless otherwise shown on the plans, water distribution facilities must comply with section 15.02 of the City of West Sacramento Standard Specifications.

77-21.03 CONSTRUCTION

Unless otherwise shown on the plans, installation of water distribution facilities must comply with section 15.03 of the City of West Sacramento Standard Specifications.

The existing water main facilities shall be cleaned of all foreign material and delivered to the City of West Sacramento Corporation Yard at, 1951 South River Road, West Sacramento, CA 95691.

77-21.04 PAYMENT

Not Used

77-22 CITY OF WEST SACRAMENTO CONCRETE CURB AND CURB RAMP

77-22.01 GENERAL

Section 77-23 includes specifications for constructing City of West Sacramento vertical curb and gutter and curb ramp.

77-22.02 MATERIALS

Not Used

77-22.03 CONSTRUCTION

Construct vertical curb and gutter per City's Standard Detail No. 201.

Construct curb ramps per City's Standard Details Nos. 208, 208A, 209, and 209A.

Truncated dome shall be constructed or installed on curb ramps in conformance with the details shown on the Standard Detail No. 210 and these Special Provisions.

City concrete vertical curb and gutter shall be constructed in conformance with section 11 of the City of West Sacramento Standard Specifications.

The Contractor shall exercise extreme care to avoid damaging the curb and gutter lips, sidewalks, and planting areas during excavation operations. Gutter lips damaged by the Contractor which are spalled more than one inch (1") deep by five inches (5") long, will be repaired at the Engineer's direction. The cost of repairs to the damaged curb and gutter shall be considered as included in the item involved, and no separate payment shall be made therefore.

77-22.04 PAYMENT

Not Used

77-23 CITY OF SACRAMENTO DRAINAGE FACILITIES

77-23.01 GENERAL

Section 77-22 includes specifications for constructing City of Sacramento drainage facilities.

City of Sacramento drainage facilities include:

1. Type B Drop Inlet (Standard Drawing No. S-10)
2. Type B Frame and Grate (Standard Drawing No. S-40)
3. Standard Manhole No. 3 (Standard Drawing No. S-70)
4. Storm Drain Message Layout (Standard Drawing No. Q-70)
5. Install Storm Drain Pipes
6. Remove inlet
7. Remove Pipe
8. Remove Manhole
9. Adjust Manhole

77-23.02 MATERIALS

Unless otherwise shown on the plans, drainage facilities must comply with sections 20 and 30 of the City of Sacramento Standard Specifications.

The clean crushed rock shall conform to Section 10-17 Clean Crushed Rock of the City Standard Specification.

The open back hood shall be cast iron or approved equal.

77-23.03 CONSTRUCTION

Unless otherwise shown on the plans, excavation for drainage facilities must comply with section 12 of the City of West Sacramento Standard Specifications.

Unless otherwise shown on the plans, improvements performed on existing drainage facilities must comply with section 13 of the City of Sacramento Standard Specifications.

Inlet to be reset or adjusted shall conform to Section 71-5.03C of the State Standard Specifications.

The inlet grate shall be installed so that either end of the grate can be lifted from the frame and removed by pulling parallel to the curb. The grate frame shall be installed between $\frac{1}{2}$ and 1 inch from the face of the open back hood. All joints and all connections between the hardware (grate and hood) and the vertical walls of the drain inlet shall be grouted forming a smooth transition with a light broom finish.

Lower and raise manholes cover by lowering before cold planing and raising after paving or surfacing. Before opening the lane to traffic, either (1) complete permanent paving or surfacing or (2) temporarily fill any depressions with HMA.

Do not adjust to final grade until the adjacent pavement or surfacing is complete.

If a manhole cover is unstable or noisy under traffic, place a coil of asphalt-saturated rope, a plastic washer, or asphaltic compound on the cover seat. Before placement, obtain authorization for use of the material.

All drain inlet pipe abandoned in place shall be plugged at both ends with two feet of Portland Cement Concrete (PCC). All pipe to be removed shall become the property of the Contractor and shall be disposed of away from the project site.

All manhole pipe abandoned in place shall be plugged at both ends with two feet of class "C" or "D" concrete. All pipe to be removed shall become the property of the Contractor and shall be disposed of away from the project site.

Backfilling shall be in accordance with the methods set forth in the Section 14 of the City Standard Specifications. The relative compaction shall be at least ninety percent (90%), unless otherwise indicated.

Restoration of surface must comply with section 13-4 of the City Standard Specifications.

The existing grates and manhole lid shall be cleaned of all foreign material and delivered to the City of Sacramento Corporation Yard, Division of Field Services, 5730 24th Street, Attention: Jeff Heard, Drainage Superintendent (916) 433-6223.

77-23.04 PAYMENT

Not Used

77-24 CITY OF SACRAMENTO CONCRETE CURBS AND SIDEWALK**77-24.01 GENERAL**

Section 77-24 includes specifications for constructing City of Sacramento concrete curbs, bioretention curb, curb and gutter, sidewalks, driveway, concrete textured paving, curb ramp and their appurtenances.

77-24.02 MATERIALS

Concrete for City of Sacramento concrete curb, curb and gutter, sidewalk, driveway, and curb ramps must be Portland cement concrete conforming to section 10-5 of the City of Sacramento Standard Specifications and these special provisions.

77-24.03 CONSTRUCTION

Construct curbs and curb and gutter per City's Standard Drawing No. T-11.

Construct curb ramp per City's Standard Drawing No. T-73.

City of Sacramento concrete curbs, bioretention curbs, curbs and gutter, sidewalk, driveway, and curb ramp shall be constructed in conformance with section 24 of the City of Sacramento Standard Specifications.

Truncated dome shall be constructed or installed on curb ramps in conformance with the details shown on the Standard Detail Drawing No. T-78 and T-79 and these Special Provisions.

Concrete (textured paving) shall be constructed in conformance with section 73-4 of the State Standard Specifications.

The Contractor shall exercise extreme care to avoid damaging the curb and gutter lips, sidewalks, and planting areas during excavation operations. Gutter lips damaged by the Contractor which are spalled more than one inch (1") deep by five inches (5") long, will be repaired at the Engineer's direction. The cost of repairs to the damaged curb and gutter shall be considered as included in the item involved, and no separate payment shall be made therefore.

77-24.04 PAYMENT

Not Used

78 INCIDENTAL CONSTRUCTION

Replace the 2nd paragraph of section 78-4.03B with:

The painted concrete on the curb and exterior face of box girder for the I street bridge replacement approach structures, portions of the stem for the retaining walls, and the retaining wall railing monuments must match color no. #27875 (Insignia White) of AMS-STD-595.

Replace section 79 with:

79 MOVABLE BRIDGE CONSTRUCTION**79-1 FENDER RUBBING STRIPS****79-1.01 GENERAL****79-1.01A Summary**

Section 79-1 includes furnishing and constructing the fender rubbing strips on the piers.

79-1.01B DefinitionsNot Used**79-1.01C Submittals**Provide submittals in accordance with section 57-3.01C and as described herein.Provide shop drawings in accordance with section 57-3.02C(2).Submit two copies of the printed literature for the product, which includes part or catalog numbers, material sizes, and lengths, types, and sizes of fasteners and connection details.Submit manufacturer's installation instructions.Submit samples of plastic lumber showing the range of variation to be expected in appearance, including surface texture, quality, and color, for acceptance by the Engineer. Provide sample not less than 12 inches long that is manufactured using the same method proposed for the work.**79-1.01D Quality Assurance****79-1.01D(1) General**Provide a 50-year limited warranty on all plastic lumber products against damage from termites or fungal decay, as well as damages caused from splitting or splintering.Transport plastic lumber using methods to minimize scratching or damage to the outer surfaces.Stack plastic lumber on dunnage above ground so that it may be easily inspected. Lift plastic lumber using nylon slings. Do not use sharp instruments in handling the product. Any plastic lumber damaged during shipping and handling will be rejected.Handle and store plastic lumber in accordance with manufacturer's written instructions.**79-1.01D(2) Quality Control**Provide Quality Control in accordance with section 57-3.01D and as described herein.**79-1.02 MATERIALS****79-1.02A General**Provide materials conforming to section 57-3.02 and as described herein.Provide materials conforming to the requirements in section 57-3.02 and as follows:

<u>Quality characteristic</u>	<u>Test method</u>	<u>Requirement</u>
<u>Impact Resistance</u>	<u>ASTM D256, Method A (Izod)</u>	<u>>0.55 ft-lbs/in</u>
<u>Tensile Properties</u>	<u>ASTM D638</u>	<u>2,200 psi at break min.</u>
<u>Compressive Modulus</u>	<u>ASTM D695</u>	<u>40 ksi min.</u>
<u>Screw Withdrawal</u>	<u>ASTM D6117</u>	<u>400 lb (screw) min.</u>

79-1.02B Reinforced Recycled Plastic LumberProvide materials conforming to section 57-3.02B except replace the second sentence of the fourth paragraph with the following:Mix the plastic for the outer skin with colorants to match color no. 37030 or 30097 of AMS-STD-595 and must contain a UV inhibitor and antioxidants.**79-1.02C Fasteners**XX**79-1.03 CONSTRUCTION**Perform work in accordance with section 57-3.03.

79-1.04 PAYMENT

Payment will be made at the contract unit price per MFBM using the volume determined from nominal widths and thicknesses and lengths shown in the plans. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to complete the fender rubbing strips as shown on the plans and as described herein.

79-2 COUNTERWEIGHTS**79-2.01 GENERAL****79-2.01A Summary**

Section 79-2 includes furnishing, fabricating, and installing the counterweights.

The counterweight ropes and castings are not included.

79-2.01B Definitions

Not Used

79-2.01C Submittals

Provide submittals for steel in accordance with section 55-1.01C.

Provide submittals for concrete in accordance with section 51-1.01C.

79-2.01D Quality Assurance

Quality assurance of concrete must comply with section 51-1.01D.

Quality assurance of steel must comply with section 55-1.01D.

79-2.02 MATERIALS**79-2.02A Concrete**

Provide concrete conforming to section 51, except as modified herein or on the plans.

Provide concrete comprised of aggregates of proper specific gravity to provide concrete nearly equal to the unit weight designated on the plans.

79-2.02B Steel

Provide steel conforming to section 55, except as modified herein or on the plans.

Provide steel conforming to ASTM A709/A709M, Grade 50W, ASTM A572/A572M, Grade 50, or ASTM A588/A588M may be substituted with the approval of the Engineer.

Paint steel surfaces in contact with the concrete with primer only.

Paint exposed exterior surfaces of steel with the same paint system used on the rest of the bridge.

Provide an anti-slip coating mechanically bonded to the top surface with a minimum Wet Dynamic Coefficient of Friction of 0.45 to meet high traction classification when tested per ANSI A326.3.

79-2.02C Bar Reinforcing Steel

XX

79-2.02D Steel Studs

Provide shear studs conforming to section 55-1.02D of the State Standard Specifications.

79-2.02E Steel Handrail

Provide steel handrail conforming to section 55-1.02D of the State Standard Specifications. Galvanize steel handrail in accordance with ASTM A123/A123M.

79-2.02F Bronze Wearing Plates

Provide bronze wearing plates in accordance with the plans.

79-2.02G Pipe Drain

Provide pipe drains comprised of PVC suitable for embedment in concrete and conforming to Schedule 40 or higher.

79-2.03 CONSTRUCTION

Produce test blocks, verify weights, and adjust weights as indicated in the plans.

Ensure that pipe drains do not crush during placement of concrete and retain their original shape after curing of concrete.

Connect pipe drains in accordance with the manufacturer's recommendations.

79-2.04 PAYMENT

Payment will be made at the contract unit price per each counterweight. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the counterweight as shown on the plans and as described herein.

Verifying, measuring, and adjusting unit weights described herein and on the plans are included with this work.

Balancing is not included with this work.

79-3 BALANCE BLOCKS**79-3.01 GENERAL****79-3.01A Summary**

Section 79-3 includes furnishing, fabricating, and installing balance blocks in the counterweights.

79-3.01B Definitions

Not Used

79-3.01C Submittals

Provide submittals in accordance with section 55-1.01C, except as modified herein.

Provide layout, dimensions, and placement details in the shop drawings.

79-3.01D Quality Assurance

Provide quality assurance conforming to section 55-1.01D, except as modified herein.

Employ a fabricator with a minimum of five years' experience producing counterweight components for movable bridges.

Inspect all balance blocks for dimensional accuracy and material integrity.

79-3.02 MATERIALS**79-3.02A General**

Provide materials conforming to section 55-1.02, except as modified herein.

Fabricate balance blocks from ASTM A36/A36M steel, unless otherwise approved by the Engineer. Galvanize balance blocks in accordance with ASTM A123/A123M.

Provide a weather-resistant, non-sag grease as a lubricant to coat all balance blocks.

Ensure that the balance blocks have clean, smooth surfaces.

79-3.02B Delivery, Storage, and Handling

Deliver, store, and handle the balance blocks in accordance with section 55-1.02B, except as modified herein.

Store balance blocks on dunnage at an area designated by the Engineer.

79-3.03 CONSTRUCTION

Install balance blocks in designated counterweight pockets as shown in the plans.

Place balance blocks in the counterweight pockets in a manner to prevent movement during operation. Adjust balance blocks as required within pockets for proper operation.

Store and arrange unused balance blocks on dunnage at an area designated by the Engineer.

Clean balance blocks of debris prior to installation.

79-3.04 PAYMENT

Payment will be made at the contract unit price per each balance block. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the balance blocks.

Payment quantity includes balance blocks stored permanently on site for future use.

79-4 PIER BRIDGE CRANE**79-4.01 GENERAL****79-4.01A Summary**

Section 79-4 includes furnishing and installing the pier bridge cranes.

79-4.01B Definitions

pier bridge crane system: one overhead crane, two crane rails, connections, and necessary controls for operation.

79-4.01C Submittals

Submit the manufacturer's product data for the pier bridge crane and controls.

Submit calculations and shop drawings for the connection of the crane rails to the pier.

Submit shop drawings for the pier bridge crane system, including electrical schematics.

Submit manufacturer's operation and maintenance instructions.

79-4.01D Quality Assurance

Provide a warranty that the pier bridge crane is free from defects due to materials and workmanship for a minimum of two years.

Calculations must be performed by a Professional Engineer registered in the State.

79-4.02 MATERIALS**79-4.02A Crane**

Provide a multi-push button pendant control station tethered to the hoist for operation of the crane.

Provide a pier bridge crane as indicated on the plans.

79-4.02B Crane Rails

Provide crane rails spanning the extents shown in the plans and that are compatible with the crane.

79-4.03 CONSTRUCTION

Install pier bridge crane in accordance with manufacturer's instructions.

Ensure crane operates free of interference with other objects and access.

79-4.04 PAYMENT

Payment will be made at the contract unit price per each pier bridge crane. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the pier bridge crane system as shown on the plans and as described herein.

79-5 PIER JIB CRANE

79-5.01 GENERAL

79-5.01A Summary

Section 79-5 includes furnishing and installing the pier jib cranes.

79-5.01B Definitions

pier jib crane system: one jib crane, anchorages, and necessary controls for operation.

79-5.01C Submittals

Submit the manufacturer's product data for the pier jib cranes and controls.

Submit calculations for the anchorage of the pier jib cranes.

Submit shop drawings for the pier jib crane systems, including electrical schematics.

Submit calculations and detailed shop drawings of anchorages for pier jib cranes.

Submit manufacturer's operation and maintenance instructions.

79-5.01D Quality Assurance

Provide a warranty that the pier jib crane is free from defects due to materials and workmanship for a minimum of two years.

Shop drawings and calculations must be sealed by a Professional Engineer registered in the State.

79-5.02 MATERIALS

Provide a multi-push button pendant control station tethered to the hoist for operation of the crane.

Provide 5-ton capacity pier jib cranes and 15-ton capacity pier jib cranes as indicated on the plans.

Custom anchorages for the pier jib cranes may be required based upon available clearance within the pier. Design custom anchorages, if required. Materials for custom anchorages must conform to the Standard Specifications and these Special Provisions.

79-5.03 CONSTRUCTION

Install pier jib cranes in accordance with manufacturer's instructions.

Ensure pier jib crane operates free of interference with other objects and access.

79-5.04 PAYMENT

Payment will be made at the contract unit price per each pier jib crane (5 ton). Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the pier jib crane (5 ton) system as shown on the plans and as described herein. Designing, furnishing, and installing custom anchorages will also be included, if required.

Payment will be made at the contract unit price per each pier jib crane (15 ton). Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the pier jib crane (15 ton) system as shown on the plans and as described herein. Designing, furnishing, and installing custom anchorages will also be included, if required.

79-6 INSPECTION TRAVELER

79-6.01 GENERAL

79-6.01A Summary

Comply with general provision requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

This work shall consist of designing, detailing, manufacturing, delivering, constructing, installing, lubricating, painting, placing into satisfactory operation, and testing the inspection traveler platform, motorized end truck, platform to end truck hanger connection system, support rail system, platform hoist system, and pier securing system for use under the lift span, and parked at the pier wall location indicated on the plans. This includes providing tools, devices, materials, apparatus, and labor. Any apparatus, tools, devices, materials, and labor not specifically stated or included, which may be necessary for the work, shall be furnished by the Contractor. The inspection traveler shall be an electrically-propelled, self-contained unit powered by the conductor bar. The inspection traveler shall be capable of connecting and disconnecting from the motorized end trucks to be able to traverse the under-side of the lift span on the installed support rail system that is attached to the floor beams on the under-side of the bridge superstructure, and parking the platform on the pier when the traveler platform is not in use.

The support rail system consists of two monorail beams for the traveler. The traveler support rails, and all fasteners, fill plates, splice plates, and shims shall be included with this work and shall be erected in coordination with the structural steel erection for the bridge superstructure.

The pier securing system consists of the method to secure the platform to the pier for long term storage.

All parts shall be new.

The work includes coordination of special machinery manufacturer requirements, special shimming and alignment, and installation and alignment of structural, mechanical, and electrical components, including motors and limit switches. The work also includes coordination with work performed by other disciplines.

79-6.01B Definitions

Not Used

79-6.01C Submittals

Comply with submittal requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

No work shall be performed, nor materials ordered without approval of submittals describing such work or materials by the Engineer.

79-6.01C(1) General Requirements

Comply with submittal requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

Submittals for the traveler work shall include calculations, shop and working drawings, layout drawings, catalog cut and specification sheets, installation details and procedures, test procedures and results, as-built drawings, operating, maintenance and lubrication manuals, and lubrication charts.

Machinery sizing calculations shall be submitted for all traveler operating, platform hoisting, supporting machinery, and all requirements within the Traveler System Design Criteria herein. Calculations shall be sealed and signed by structural, mechanical, and electrical Professional Engineers registered in the state of California.

No work shall be performed, nor materials ordered without approval of submittals describing such work or materials by the Engineer.

79-6.01C(2) Manufactured Items

Comply with submittal requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.01C(3) Final Record Drawings ("As Built" Drawings)

Comply with As-Built Drawing submittal requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.01C(4) Operation and Maintenance Manual and Training Requirements

Comply with Operating and Maintenance Manual and Training Requirement submittal requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and in accordance with section 78-34 OPERATING, MAINTENANCE, AND LUBRICATION MANUALS AND TRAINING and all requirements herein.

79-6.01D Quality Assurance**79-6.01D(1) General**

Comply with quality assurance requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.02D(2) Notice of Beginning of Work

Comply with Notice of Beginning of Work requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.02D(3) Limits of Work

The limits of the work included in this item shall be as indicated on the Contract Plans and as specified herein.

79-6.02D(4) Standards and Codes

Comply with Standards and Codes requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

Comply with the following standards and specifications as applicable. Where not otherwise specified herein, workmanship, materials, fabrication and erection of the bridge components shall be in accordance with the requirements of the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications, Eighth Edition with California Amendments, 2019 and the AASHTO LRFD Movable Highway Bridge Design Specifications, Second Edition, 2007 with 2018 Interim Revisions.

Comply with all applicable requirements, codes and standards issued by the following organizations:

American Society for Testing and Materials (ASTM)

American National Standards Institute (ANSI)

American Society of Mechanical Engineers (ASME)

American Gear Manufacturer's Association (AGMA)

Society of Automotive Engineers (SAE)

American Welding Society (AWS), Bridge Welding Code, D1.5

American Bearing Manufacturers Association (ABMA)

American Iron and Steel Institute (AISI)

American Institute of Steel Construction (AISC)

Association for Materials Protection & Performance (AMPP, formerly SSPC & NACE)

Occupational Safety and Health Administration (OSHA)

National Electric Manufacturers Association (NEMA)

National Fire Protection Association (NFPA)

Crane Manufacturers Association of America (CMAA)

The work shall meet the requirements of all codes and standards specified herein. Where codes and standards are mentioned, it is to call particular attention to their requirements – it shall not be assumed that the requirements of any other codes or standards are to be omitted or are not applicable if not mentioned.

Work shall comply with all applicable Federal, State and Local rules, regulations, and ordinances.

In the event of a conflict between these specifications and the above-mentioned codes, standards, rules, regulations and ordinances, the most stringent requirement shall apply.

79-6.01D(5) Quality Control

Comply with Quality Control and Warranty requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.01D(6) Contractor Experience

Comply with Contractor Experience requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

The professional engineers designing and detailing the Traveler System, as required herein, must have performed similar design work on a minimum of two Travelers in the last ten years.

The Contractor, suppliers, and onsite supervisory personnel of the installation and operation of the new machinery must each have performed similar work on a minimum of one Traveler in the last five years.

Submit to the Engineer for evaluation, a tabulation of experience in the design, detailing, fabrication, and installation of traveler systems. The list of experience submitted to the Engineer must include experience of professional design engineers, machinery suppliers and subcontractors, specifically for traveler systems.

79-6.01E Traveler System Design**79-6.01E(1) Professional Engineering Designers**

Engage the services of professional engineers registered in the state of California to design and detail the Traveler System. These services shall include any required consultation for interpreting the plans and Special Provisions and for the resolution of problems which may arise during the performance of the work.

Submit complete design calculations, manufacturer recommendations, shop drawings, installation procedures, and training details and procedures signed and sealed by structural, mechanical, and electrical Professional Engineers registered in the state of California.

79-6.01E(2) Traveler System Design Criteria

Develop all Traveler System design and details in conformance with the codes listed herein and to meet the following design criteria:

1. General

Design all Traveler Systems to meet the requirements within CMAA Spec 70 and CMAA Spec 74. Provide the traveler supporting and operating systems, as shown on the plans, with the motorized end trucks remaining attached to the support rails on the lift span. The traveler platform is intended to be removable from the end trucks to allow the platform to be parked on the pier while it is not in use. The traveler platform is not intended to remain on the lift span when it is not in use.

Propose, to the Engineer for review and approval, any alternative concepts. Submit all complete calculations and drawings, as required by the Engineer, for all proposed alternative concepts.

Utilize stainless steel for machinery components when function prevents them from being coated. Utilize severe duty protection for marine type environments for all coated components.

Verify that all designed systems and components do not interfere with any other components throughout the rest of the structure, pier, access, electrical system or any other part of the work through all positions of the Traveler Platform and End Trucks in the intended area of its travel and hoisting positions. Propose, to the Engineer for review and approval, any required modifications to the Traveler System or other bridge systems.

Where materials are not specified herein, the designer must select based on calculation results and list in the design specifications or on the design plans. Submit all details to the Engineer for review and approval.

2. Traveler Platform

Fabricate the traveler structural platform as shown on the plans and Special Provisions. Propose any necessary modifications of the traveler structure to the Engineer for review and approval. Do not modify the traveler structural platform details without review and approval from the Engineer. Submit signed and sealed calculations and drawings for all proposed platform modifications.

3. Motorized End Trucks

Design and develop motorized end trucks that meet the following requirements.

1. Provide motorized end trucks that ride along the support rails and power the traveler to traverse below the lift span. Provide the capability to connect and disconnect the end trucks from the Traveler Platform through the Platform Hanger Assembly, required herein.
2. Motorized End Truck Capacity: Design each motorized end truck normal working capacity to be rated to support 21 kips, this includes half of the deadload of the Traveler Platform and the platform design live load.
3. Speed Requirements: Provide motorized end truck drive systems designed to operate at three speeds, full speed at 75 feet per minute, reduced speed at 35 feet per minute, and creep speed. Incorporate the ability to adjust the traveler set speeds and acceleration ramps in the traveler control system. Set acceleration ramps for less than or equal to 0.25 ft/s^2 .
4. End Truck Motor Sizing: Provide motorized end trucks with a minimum of 4 motorized wheels per end truck. Design the motorized end truck with four 1 hp electric motors, per end truck, and drive systems to start, accelerate, and maintain a constant velocity at the reduced speed of 35 feet per minute, against a 6.5 psf wind load, friction, slope of the rails, and inertia in dry and wet weather conditions. Design the motorized end trucks with the same forward and reverse capabilities. Design all speeds to operate against friction and the slope of the rails in dry and wet weather conditions. Include gear train efficiencies in design calculations. Projected wind area may be reduced by 15% for non-solid members and wire mesh cloth. Utilize the same total dead load and live load weight used for motor sizing as listed for the End Truck normal working capacity above. Ensure drive system is designed to resist overhauling loads listed above when traveling down the slope at 35 feet per minute with overhauling wind load. Utilize 208 volt, 3 phase, 60 Hz, TENV, continuous duty rated motors. Power the end truck motors from the electric conductor bar. Incorporate rear shaft extensions for each motor, with a square end, for use with a manual hand crank for emergency operation. The shaft extension shall have a removable cover. When a cover is removed, a limit switch shall disable electric operation of all motors.
5. End Truck Brake Capacity: Provide a spring set, electrically release brake on each end truck motor, with external manual over-ride break release lever. Size brakes for all CMAA dynamic and parking brake requirements utilizing the same design loads as listed above for the end truck motor sizing. Utilize brakes with manual release levers that stay released when manually released. Incorporate a manual brake release limit switch on each motor brake that trips and disables the electric operation of all motors if any of the motor brakes are manually released.
6. Manual Operation: The motorized end trucks shall be provided with the ability to operate manually. Provide hand cranks required to operate the traveler manually. Follow all OSHA, AASHTO, and CMAA requirements for manual operation power requirements to operate the traveler up the slope of the rails against friction. Assume no wind load for manual operation sizing. Assume a two person manual operation for the traveler.
7. Motorized End Truck Components and Features: Provide motorized end trucks with a wheel base that conforms to required codes and manufacturer recommendations for the support rail span in this application. Include side guide rollers capable of resisting any skewing or transverse forces and with the capability to keep the main wheels centered on the support rail. Provide motorized end truck assemblies with retraining lugs to maintain connection with the support rails in the event of failure of the motorized end truck wheel assemblies. Provide an articulating load connection between the end truck trolley wheels and end truck assembly to allow the trolley wheels to self-align and compensate for minor changes in the support rails. Prevent runaway scenarios by designing the motorized end truck assembly such that either all wheels in contact with the rails are restrained by the brakes or include features to prevent loading conditions to potentially cause only the uncontrolled supporting wheels to remain in contact with the support rail. Size components to conform to CMAA Class D. Provide stainless steel end truck wheels with minimum 250 BHN hardness for custom designs or end truck wheels provided by end truck manufacturers recommended for this application. Match wheel treads with the runway beam (straight or tapered profile). Provide bearings with a minimum B-10 bearing life of 5,000 hours.
8. Submit calculations to ensure the avoidance of wheel skidding scenarios with the drive system design. Utilize a dead load of 12 kips per end truck for this calculation.
9. Include severe duty protection with epoxy windings and space heaters for motors and brakes.

4. Support Rails

Design and develop support rails for the motorized end trucks that meet the following requirements.

1. Support Rail Capacity: Design support rails that are made by the same manufacturer as the end trucks. Design support rails to not exceed 1/600th vertical deflection criteria for the maximum rail span between floorbeam connections and a 30 kip load per end truck assembly. Design support rails to not exceed 1/400th lateral deflection criteria for the maximum rail span between floorbeam connections and a 3 kip transverse load, per rail. Design support rails to not exceed 1/400th lateral deflection criteria for forces due to skewing. Examine actual potential skew forces from the end trucks as well as assumed skew forces from CMAA. Ensure support rails meet all applicable codes and manufacturer recommendations. Provide bracing as required for capacity and deflection.
2. Support Rail Height: Select support rails that do not extend below the bridge low steel elevation requirements listed in the plans.
3. Support Rail Connections: Design connections and splices for support rails in accordance with AASHTO LRFD Bridge Design Specifications, Eighth Edition with California Amendments, 2019. Rail splices shall occur only at the bridge main floorbeams and shall be a standard manufacturer's splice, as detailed by the manufacturer for the support rail. Determine if extra support rail splice plates are required beyond the manufacturer's standard splice plates.
4. Installation Tolerance: Install support rails with tolerances that meet CMAA and manufacturer requirements, whichever is more stringent. Stagger rail joints, rail to rail, if recommended by the manufacturer.
5. Support Rail Features: Include rubber bumpers at both ends of the support rails that prevent the end trucks and traveler platform from interfering with any lift span or pier components. Incorporate bumpers with sufficient capacity to stop the traveler from full speed impact.

5. Bridge Balance Coordination

Coordinate weights of support rail and end trucks with final lift span and counterweight balance calculations and details. Propose to the Engineer for review and approval and modifications required to accommodate the weight of these components.

6. Platform Hanger Assembly

Design and develop the platform to end truck hanger assembly that meet the following requirements.

1. Hanger Assembly Capacity: Design a minimum of four hanger assemblies to connect the platform to the end trucks, two total per end truck, four total per traveler platform. Design each hanger assembly for a normal working capacity of 15 kips. This load assumes a scenario where the dead load of the platform is shared unevenly 75% to 25% between the two hangers on one end truck. Ensure all assembly and connection components are designed for all potential loading conditions including, drive system operating forces, braking forces, and skew forces. Ensure design meets all AASHTO, CMAA, and OSHA rating requirements and safety factors.
2. Redundancy: Provide redundant hanger connections between the end trucks and platform at each corner.

7. Platform Hoist System

Design and develop the platform hoist system that meet the following requirements.

1. Platform Hoist System Capacity: Provide hoist systems with capacity to lift the platform with capacity in accordance with all applicable codes for jacking or hoisting systems.
2. Redundancy: Provide hoist systems with redundant primary and backup connections to the platform.
3. Power Requirements: Provide an electrically powered primary hoist system.

8. Machinery Guards and Covers

Design and develop machinery guards and covers that meet the following requirements.

1. Design and install guards attached to the end trucks that protect personnel from the electric conductor bars while working on the Traveler Platform.

2. Design and install guards attached to the pier walkway access that protect personnel from the electric conductor bars while using pier access walkways.
3. Design and install covers installed in the lift span that protect the motorized end trucks from rain and debris when parked in the parked position, above the pier traveler platform parked position.
4. Design and install covers installed in the lift span that protect the electric hoists from rain and debris.
5. Design and install covers at all exposed rotating components in the motorized end truck assemblies.
6. Utilize guards, covers, supports, and fasteners constructed of Type 316 stainless steel, No. 16 minimum thickness.
7. Design guards and covers to be removable if additional access is required. \
8. Rubber edge trim with metal core shall be used to provide protection on edges of covers and guards, especially where personnel contact or chafing of electrical wiring could occur.

9. Skew Monitoring System

Provide wheel encoders at each end truck and PLC to compare position of each end truck and calculate skew. Program PLC with function to generate "skew output" when skew warning is determined necessary by the Contractor.

10. Electrical Power and Control System

Contractor to verify all details with what is shown in electrical drawings and specs and propose any necessary modification for review and approval to provide a fully functional electrical power and control system for the traveler.

1. Electrical

1. Provide full speed and reduced speed capability with reduced speed 20% of full speed. The reduced speed is a starting point for startup and adjustments may be required after operational data is available.
2. Motors shall be induction, inverter duty, continuous duty, TENV, 460V three-phase, 60 Hertz. Driven with variable frequency drives as shown on Plans.
3. Provide a conductor bar/rail system, 480V three-phase, to supply continuous power to the traveler. Provide a guard at the traveler to prevent inadvertent contact with the conductor bar/rail system.
4. Control system and features as shown on Plans.
5. Provide NEC working clearance in front of all electrical cabinets.

79-6.02 MATERIALS

Comply with material requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-6.02A Spare Parts

Provide the following spare parts protected and stored with the manufacturer's recommended long term storage protection. Store all other parts as directed by the Engineer without additional cost.

1. Two spare motorized end truck motor and brake assemblies.
2. One motorized end truck drive train assembly.
3. Four main pin assemblies and four alignment pin assemblies.
4. Four manual hand cranks.
5. Two electric hoist assemblies.
6. Four secondary hanger assemblies.
7. Four hoisting backup assemblies.
8. One backup manual hoist assembly.

79-6.02B Electrical and Control System

General Electrical Material: Unless noted otherwise, all electrical and control devices shall be as indicated on the plans and in the Special Provisions for the Movable Bridge Electrical and Control System.

79-6.02B(1) Programmable Logic Controller (PLC) System

Use the same PLC product as the bridge PLC, and a separate stand-alone controller for the traveler.

79-6.02C Steel Floor Grating

Provide steel floor grating of the size designated on the plans that conforms to ANSI/NAAMM – MBG 531-24. Galvanize grating in accordance with ASTM A123/A123M after fabrication.

79-6.02D D-Ring for Anchor Plate

Provide galvanized D-rings with anchor plates that meet or exceeds all applicable industry standards including OSHA and ANSI/ASSE Z359 with a minimum strength of 5,000 lb.

79-6.03 CONSTRUCTION

Comply with construction requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

Work shall be performed in accordance with section 55-1 of the State Standard Specifications, except as modified herein or on the plans.

Unless noted otherwise, all electrical and control devices shall be as indicated on the plans and in the Special Provisions for the Movable Bridge Electrical and Control System.

79-6.04 PAYMENT

Payment will be made at the contract lump sum price for the inspection traveler. Payment includes full compensation for designing, detailing, testing, labor, materials, tools, equipment, and incidentals necessary to complete this work as shown on the plans and as specified herein.

The inspection traveler consists of the traveler platform, the motorized end trucks, support rails, bridge balance coordination, hanger assemblies, hoist systems, guards, covers, electrical details, skew monitoring system, and all incidentals shown on the plans and as specified herein.

79-7 MOVABLE BRIDGE PROJECT COORDINATOR**79-7.01 GENERAL****79-7.01A Summary**

Designate a specific individual responsible for all duties defined below as the Movable Bridge Project Coordinator. Perform coordination tasks including, but not be limited to: assist the Contractor with span alignment and measurements; conduct span balance testing; develop installation procedures; develop calculations for temporary conditions as required; assist with integration of mechanical and electrical equipment; confirm acceptability of bascule span structural members; and assist the control system integrator during field tests.

79-7.01B Definitions

Not Used

79-7.01C Submittals

Not Used

79-7.01D Quality Assurance

Not Used

79-7.02 MATERIALS

Not Used

79-7.03 CONSTRUCTION

Retain the services of a State of California to serve as Movable Bridge Project Coordinator (MBPC). Submit qualifications to the Engineer for approval at least 14 calendar days prior to the project preconstruction meeting. The MBPC must have a minimum experience of coordinating structural, mechanical, and electrical work on two movable bridge projects within the past 5 years with a construction cost of at least \$8 million for

each qualifying project. Submit to the Engineer, written evidence of the willingness of the MBPC to commit fully throughout the duration of the project as part of the qualification for the individual. Changes to the MBPC require prior approval from the Engineer and will not be allowed until a successor has been approved by the Engineer.

The MBPC is responsible for coordinating all construction work on the movable bridge portions of the project, from shop drawing preparation and review through field work and final acceptance, so that the Contractor and all subcontractors perform in a timely and organized manner, working toward the common goal of finishing the project in accordance with the approved schedule and in accordance with the contract.

The MBPC must participate in development of all project schedules to assure adequate planning and execution of the movable bridge work. The schedule must allow adequate time to review the individual submittals.

The MBPC will be responsible for coordination of all work included for all disciplines related to the movable bridge.

The coordination functions and responsibilities of the MBPC must include but are not limited to:

Coordinating and tracking shop drawings as required from all suppliers, fabricators, and subcontractors relating to the pay items listed above.

Exchange of necessary data related to the movable bridge portion of the project between subcontractors.

Review of all Contractor substitution of alternate brands of components, substantiation of equivalency, and coordination of all approvals to all revisions necessitated by the substitution.

Review submittals of shop drawings, catalog cuts, manufacturer's literature, and operating and maintenance manuals for items related to the pay items listed above prior to submitting to the Engineer. The MBPC's review indicates that the submittal meets the contract requirements, including technical specifications, format, clarity, and completeness.

Review construction methods, construction sequences, and performance of work in accordance with the requirements of the contract related to the pay items listed above. The MBPC's review of any construction sequence indicates that they have agreed the proposed sequence does not involve unnecessary risk to the structure or any personnel. The MBPC's review also indicates that the proposed sequence meets contractual requirements for tolerances and material handling.

Review balance testing procedures and calculations. The MBPC's review of the balance testing and calculations indicates that they are complete, consistent with typical industry practice, and meet all contractual requirements.

Review the Operating and Maintenance Manuals and Training prior to each submittal to the Engineer. The MBPC's review of the Operating and Maintenance Manuals indicates that they are complete and meet all contractual requirements.

Assist the Contractor in coordinating all structural, mechanical, and electrical field work, including navigational restrictions, temporary supports, bracings, jacking, installations, and removals related to the pay items listed above. The ultimate responsibility for these items lies with the Contractor.

Ensure submittals reviewed by the MBPC are stamped on the first sheet indicating that it was reviewed, the reviewer's name, and the date it was reviewed.

The MBPC will attend all meetings involving the movable bridge construction project and attended by any combination of Contractor, subcontractor, material suppliers, and the Engineer. The MBPC will be the individual to whom all questions relating to the construction of the bridge's movable components will be addressed.

79-7.04 PAYMENT

Payment includes all costs for labor, equipment, training, qualifications, meetings, engineering, reviews, submittals, and other services as necessary to fulfill all requirements described in this special provision and as necessary to construct the bridges using model files. This work will be paid for under the Movable Bridge Project Coordinator pay item.

The pay item will include partial payments using the following milestone schedule:

1. Engineer approval of Bascule Span Structural Steel Shop Drawings. 30 percent
2. Engineer approval of Electrical Shop Drawings. 30 percent
3. Engineer acceptance of final balance calculations and testing. 20 percent
4. Engineer acceptance of Operations and Maintenance Manual. 20 percent

79-8 BRIDGE MACHINERY COMMON PROVISIONS

79-8.01 GENERAL

79-8.01A Summary

This work consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the following items:

- BRIDGE OPERATING MACHINERY
- COUNTERWEIGHT SHEAVE ASSEMBLIES
- OPERATING DRUM ASSEMBLIES
- WIRE ROPES AND ACCESSORIES
- SPAN LOCKS
- SPAN AND COUNTERWEIGHT GUIDES
- OPERATION AND MAINTENANCE MANUAL AND TRAINING REQUIREMENTS

Include all special machining, equipment, tools, and installation as part of the work items.

The work includes coordination of special machinery manufacturer requirements, special shimming and alignment, and installation and alignment of electrical components, including motors and limit switches. The work also includes coordination with work performed by other trades and subcontractors, particularly that specified in the Electrical Plans and Specifications.

79-8.01B Definitions

Not used.

79-8.01C Submittals

Do not perform any work or order any materials without approval of submittals describing such work or materials by the Engineer.

Submit a single, detailed, coordinated schedule of submissions, including submission information from each supplier prior to any other submittals. Include in the schedule a complete list of all anticipated submissions, including, but not limited to shop drawings, assembly drawings, erection drawings, catalog cuts, installation procedures, welding procedures, paint materials and procedures, along with estimated times when submissions will take place. Coordinate the activities of suppliers and identify information and submissions generated by one or more suppliers that may be needed by other suppliers to complete their submissions as part of the work in preparing this list. Submit this schedule for review to the Engineer.

79-8.01C(1) General Requirements

Number all submittals sequentially. Number resubmittals using the original submittal number followed by an alphabetic suffix

Submit all submittals in Portable Document Format (PDF). Generate all shop drawings in computer-aided design and drafting software (CADD) and submit them as an original PDF generated from the CADD software package. Make all catalog cuts and other documents text searchable PDF documents when possible. Scan catalog and other documents using 300 dpi resolution, and in 8-bit up to 24-bit color. Only submit scanned catalog cuts and other documents when the original documents are not available in PDF format.

Fully define all details and assemblies in shop drawings, indicate the methods and sequences to be employed in the assembly and installation of bridge machinery, and present the installation of necessary utilities, support, and service facilities.

Ensure the contractor submits all copies of producer, or manufacturer data e.g., ratings, specifications, test results, catalog cuts, and installation instructions for the following items:

- Mill reports, inspection reports, and physical tests of all metals

- Bolts, nuts, washers, and other fasteners
- Paint
- Lubricants as endorsed by each unique machinery manufacturer
- Lubricants as endorsed by wire rope manufacturers
- Results of required rope tests presented herein
- Standard and custom-manufactured purchased components
- Buy America Certification for all applicable products

Ensure the contractor prepares a complete list of all machinery items which require lubrication. Include the type of lubricant used and the date it was installed and lubricated by the Contractor. Provide this to the Engineer prior to start up and testing of the machinery.

Provide submittals that are neat and legible, clearly show dimensions and pertinent ratings, and be marked to explicitly identify the intended use of each component on this project. Clearly mark the specific item(s) being proposed where a catalog cut sheet is submitted with a table, listing or group of similar items with different catalog numbers and/or options.

Provide complete details of classification of materials, schedules for fabrication, shop assembly procedures, and diagrams showing sequence and details for erection in submittals. Resubmit submittals that have not been approved or require correction until they are acceptable to the Engineer, and such procedure is not considered a cause for delay. The Contractor bears all costs for damages which may result from ordering or fabrication of any materials prior to acceptance of Shop Drawings. The Contractor may request in writing from the Engineer for approval to order raw materials of the correct type for later fabrication from approved Shop Drawings after they have been accepted. Approval by the Engineer will be in writing.

Do not commence installation and assembly of new mechanical components without approved installation and/or alignment procedures and supporting Assembly or Erection Drawings.

79-8.01C(2) Manufactured Items

Submit shop drawings to the Engineer for review and approval in accordance with these specifications. Include complete details, classification of materials, schedules for fabrication and shop assembly, weld procedures and qualifications, procedures, proof of established manufacturer specified elsewhere in these Contract Documents, and diagrams showing sequence and details for erection and approval. The Contractor is responsible for providing all field measurements and erection layouts necessary to fully define the details of all fabricated components. Reformatted contract plans, without complete manufacturing and erection information as set forth herein, are not considered satisfactory shop drawings.

Show all external dimensions and clearances necessary for installation and operation of each item of machinery on the bridge in the shop drawings.

Give a suitable title to shop drawings for fabricated detail parts to describe the parts detailed thereon. Identify each drawing by the complete project name and number. Ensure shop drawing submittals are complete and organized to allow review and evaluation of logical groups of items, and submit these groups separately to allow adequate review. Submittals may be rejected by the Engineer if the organization is deemed to limit or impede the Owner's future use of the shop drawings. Make all attempts to submit submittals for review as soon as they are ready rather than holding onto them and submitting in bulk. Submissions consisting of the entire machinery or of large groups, or multiple packages submitted in rapid succession are subject to longer review times. Include the interfaces between adjacent or connected parts in shop drawings, as well as the following information:

- Dimensions, call-outs and notes to completely define the form, fit, function, manufacturing process and allowable deviations for each feature of each item.
- Material specification for each item.
- Heat treatment, specific hardness, and/or mechanical property requirements when mandated.
- The surface finish of machined surfaces and tolerances for each dimension for which a specific fit is required. Use a general tolerance block to define the tolerances of all other dimensions. Ensure fits and finishes are the more rigorous of American Association of State Highway and Transportation Officials Movable Highway Bridge Design Specifications (AASHTO MHBDS) or manufacturer specifications.
- Quantities of all details required for their associated assemblies and quantities of complete assemblies for the entire bridge.

- Show component weights on the same shop drawing as the component detail.

Obtain approval from the Engineer for all submittal items prior to purchase, fabrication, or installation of the items.

1. Give shop drawings for manufactured or purchased assemblies a suitable title describing the parts detailed, and include the following: Complete data on the design and construction of all detail components furnished as part of the machinery under this Contract.
2. Show all proprietary items (e.g. enclosed gearboxes, brakes, etc.) in outline on shop drawings.
3. Provide complete assembly diagrams for proprietary components that show each part contained within the item and its corresponding manufacturer's part number. Provide diagrams sufficient to enable complete disassembly and reassembly of the component and to define and procure proper spare or replacement parts.

If any part is modified from its original manufacturer's description or delivery, deliver a drawing detailing each modification and assign a unique part number to ensure proper spare or replacement parts can be procured. Include in the component assembly drawings:

- Dimensions of all principal elements within the item
 - Certified external dimensions and clearances affecting interfaces or installations
 - Gross weight
 - Capacity and normal operating ratings
 - Method and recommended type and quantity of lubrication, including location and type of fittings and provisions for adding, draining, and checking the level of each lubricant employed
 - Inspection openings, seals, and vents
 - Details of all turned bolts used to mount the machinery to its supports
4. Furnish complete data on the design and construction of any unit provided as part of the machinery under this Contract, including material specifications, cross-section assembly drawings, detail drawings, and dimensions of principal elements.
 5. Include complete shop bills of materials for all machinery parts. If the bills are not shown on the shop drawings, furnish prints of the bills for approval in the same manner as specified for the drawings. State the computed weight of each piece of machinery on the shop drawing upon which it is detailed.
 6. Furnish fully detailed and complete assembly and erection drawings. Provide identification of, and essential locating dimensions for, each part or assembly with respect to the bridge or foundation..
 7. Determine the final dimensions of parts involving commercial products, such as motors, gearboxes, bearings, electrical equipment, hydraulic equipment, etc., from certified drawings of the commercial products before making shop drawings.
 8. Submit certified drawings with the affected shop drawings. Submit certified drawings for approval prior to purchasing all standard or semi-standard machinery components, including motors, brakes, reducers, couplings, turned bolts, bearings, and similar items.

Submit certified prints for all purchased components for approval by the Engineer. Ensure the certified print provides the following information:

- All external dimensions and tolerances including shaft sizes, bores and keyways
- Housing, gear and shaft materials
- Internal views showing each reducer component with part numbers
- The ratings that will appear on the nameplate
- Location of all lubrication connections
- Lubrication recommendations

Submit detailed procedures for installation, alignment, testing, and indexing of all bridge machinery to the Engineer for approval before construction. Ensure the procedures include the following:

- Bridge Operating Machinery and Alignment Procedure
- Bridge Operating Machinery Indexing Procedure
- Span Lock Machinery Installation and Alignment Procedure
- Span Guide Installation and Adjustment Procedure
- Counterweight Sheave Assembly Installation and Alignment Procedure
- Counterweight Wire Ropes Installation and Tensioning Procedure
- Operating Drum Assembly Installation and Alignment Procedure
- Operating Wire Rope Installation and Tensioning Procedure

- Strain Gage Span Balance Testing Procedure

79-8.01C(3) Final Record Drawings ("As Built" Drawings)

Maintain As-Built Drawings on site as a full-size set of shop drawings, erection layouts, and plans, marked with changes or revisions to reflect the as-built or as-installed condition. Update these drawings weekly so that no changes or deviations remain undocumented for more than one week. Use these working drawings as the basis for the deliverable As-Built Drawings. Ensure As-Built Drawings present complete details of all parts as installed on the bridge, and submit them to the Engineer as finished, formal drawings within 30 days after completion of all work. Account for any differences between approved shop drawings and field adjustments as required by actual conditions.

79-8.01D Quality Assurance

79-8.01D(1) General

Allow the Engineer to inspect and verify procedures and operations performed during installation of bridge operating machinery and wire rope assemblies as deemed necessary at the discretion of the Engineer.

1. Inspection.
Allow inspection and testing of materials and fabrication procedures in the mill, shop, and field by the Engineer. Such inspections do not relieve the Contractor of responsibility for compliance with specified requirements.
2. Design of Items and Connections
Verify all dimensions and details at the site before proceeding with any work. Treat details shown on the contract plans as typical and applicable to similar conditions unless otherwise indicated. Avoid delays by confirming accuracy before starting work.

Have the Engineer review all QC records and test reports submitted by the Contractor's Quality Control Manager.

1. Certified Test Reports.
As used herein, certified test reports refer to reports of tests conducted on previously manufactured materials or equipment identical to that proposed for use.
2. Factory Tests.
As used herein, factory tests refer to tests required to be performed on the actual materials or equipment proposed for use. Submit results of the tests in accordance with the provisions of this Contract for laboratory test results.

The Engineer may reject materials and workmanship that do not conform to the requirements of the contract. Inspection of material and workmanship may be conducted before, during, and after fabrication, as deemed necessary by the Engineer. The Engineer may reject materials and workmanship which are "in the process" of being fabricated and are found to contain defects or to have been subjected to damaging fabrication procedures while still in process. The Engineer has the right to perform, at the expense of the Owner, non-destructive tests of material and workmanship. At the discretion of the Owner, Quality Assurance functions may be exercised on site and at the mill and shop. Have the contractor furnish means and assistance for testing materials and workmanship without cost to the Owner.

The Owner's QA program, including a review of tests reports, and mill, shop, or field inspections, does not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

Provide free and safe access at all times to any portion of shops and field where work is being done under these specifications for the Engineer.

79-8.01D(2) Notice of Beginning of Work

Give the Engineer ample notice of the beginning of work at the fabrication area, so that a Representative may be on hand for inspection. Material will not be manufactured or work performed before the Engineer has been so notified.

79-8.01D(3) Limits of Work

Indicate the limits of the work included in this item on the Contract Plans and as specified herein.

79-8.01D(4) Standards and Codes

Ensure workmanship, materials, fabrication and erection of the bridge components are in accordance with the requirements of The American Association of State Highway and Transportation Officials Standard Specifications for Movable Highway Bridges (AASHTO), where not otherwise specified herein, except as otherwise noted on the Contract Plans or otherwise specified herein.

Ensure all work complies with all applicable requirements, codes and standards issued by the following organizations:

- AASHTO – The American Association of State Highway and Transportation Officials
- ASTM - American Society for Testing and Materials
- ANSI - American National Standards Institute
- AISI – American Iron and Steel Institute
- AISC – American Institute of Steel Construction
- ASME – American Society of Mechanical Engineers
- ABMA – American Bearing Manufacturers Association
- SAE - Society of Automotive Engineers
- AGMA - American Gear Manufacturers Association
- AASHTO/AWS - American Welding Society, Bridge Welding Code, D1.5M/D1.5
- NEMA - National Electrical Manufacturers Association
- AMPP - Association for Materials Protection and Performance (Formerly SSPC and NACE)
- OSHA – Occupational Safety and Health Administration
- NFPA – National Fire Protection Association

Additional organizations may also issue codes or standards applicable to the work. The work must comply with all such standards.

Meet the requirements of all other codes and standards specified elsewhere in the Standard Specifications and Special Provisions. When a code or standard is mentioned for any pay item, give particular attention to its requirements. Do not assume that the requirements of other applicable codes or standards are omitted or inapplicable if not specifically mentioned.

Comply with all applicable Federal, State and Local rules, regulations, and ordinances for the work.

In the event of a conflict between these Provisions and the above-mentioned codes, standards, rules, regulations and ordinances, follow the most stringent requirement.

79-8.03D(5) Quality Control

Maintain and take responsibility for the Quality Control of the installation of the bridge operating machinery. Have the Quality Control (QC) Manager perform inspections for all mechanical components covered under this section, including witnessing required testing, monitoring installation and alignment work, and ensuring that all work complies with the Contract Plans, Specifications, manufacturer's installation procedures, and all applicable Codes and Standards.

Have the Quality control manager maintain documentation of all required mechanical testing and submit it to the Engineer in a timely manner.

Have the Contractor's Quality Control program notify the Engineer immediately for clarification whenever any portion of the work is not clearly or accurately defined.

Warranty: Remedy defects due to workmanship, erection, materials, or design for a period of one year after final tests and acceptance, at no additional cost to the Owner. Furnish a satisfactory guarantee to ensure correction of defects. If necessary, defects may be corrected by others at the Contractor's expense.

79-8.03D(6) Contractor Experience

Ensure that the Contractor, suppliers, and onsite supervisory personnel involved in the installation and operation of the new machinery have performed similar work on at least one vertical lift bridge within the last ten years.

Submit to the Engineer a tabulation of experience in the installation of movable bridge operating machinery, specifically for vertical lift bridges. Include in the submittal the relevant experience of machinery suppliers and subcontractors, also specific to vertical lift bridges.

Ensure that the counterweight rope tensioning subcontractor has a minimum of 5 years' experience in measurement and directing the adjustment of counterweight rope tensions on vertical lift bridges.

Ensure that the strain gage testing subcontractor has a minimum of 5 years' experience in strain gage balancing vertical lift bridges.

79-8.02 MATERIALS

79-8.02A General

Ensure all materials are as called out on the Contract Plans and as indicated in the Specifications.

Ensure that the current issue of all material specifications and standards is in effect on the date of the bid for this project.

Ensure all mechanical components and materials are new, clean, and free of defects, and conform to standard ASTM and other specifications included previously and indicated on the drawings and herein, or as may be otherwise applicable.

Ensure Brinell hardness tests are made, and included on inspection reports, for all castings and forgings.

Ensure no item is fabricated, machined, welded, cast or forged without a minimum of 14 days advance notification to the Engineer to permit scheduling of required inspection. Ensure the Contractor furnishes all facilities and provides free access at the plant or shop for the inspection of material and workmanship. Ensure inspection and testing conforms to the following requirements:

1. Inspection at the plant or shop will not relieve the Contractor from responsibility for furnishing satisfactory materials and workmanship. Acceptance of a material or item does not prevent subsequent rejection if material is found defective.
2. Ensure the contractor furnishes the Engineer with the number of copies of purchase orders as may be required.
3. Unless otherwise provided, the Contractor will furnish, without charge, test specimens required herein, and all labor, testing machines, tools and equipment necessary to prepare the specimens and to make the physical tests and analyses. Furnish two copies of test reports and chemical analyses to the Engineer.

79-8.02B Substitutions

Ensure that any proposed substitutions for the specific manufacturers and/or models shown on the Contract Plans satisfy all listed requirements, are appropriate for the intended application, and are approved by the Engineer as substantially equivalent to the specified items.

Take full responsibility for all design modifications, engineering analysis, and documentation required by the Engineer as a result of any proposed substitution.

79-8.02C Manufacturer's Recommendations

When installation procedures for an item or component are required to be in accordance with the recommendation of the manufacturer, furnish printed copies of the recommendations to the Engineer prior to installation. Do not proceed with installation of the item until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

79-8.02D Standard Products

Ensure materials and equipment are standard, current production, cataloged products of manufacturers regularly engaged in production of such materials or equipment and have at least two years of defect free commercial or industrial use prior to bid opening and the latest design that complies with the requirements of these contract documents. Where two or more units of the same class of equipment are required, these units be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Ensure each assembled component has a conspicuous, durable, permanently affixed nameplate that includes at least the following information: the manufacturer's name, address, the component model number, serial number, rated capacity and pertinent factory setting(s). The nameplate of the distributing

agent will not be accepted. Furnish copies of nameplates and/or equipment tags as part of the shop drawing and included in the Operation and Maintenance Manual for future reference on all machinery.

Materials of equal or greater strength and corrosion resistance than shown on the Contract Plans may be proposed and are subject to approval by the Engineer. Similarly, submit commercial components proposed to be supplied by alternative manufacturers to the Engineer for approval. The Contractor is responsible for proving equality with the originally specified component.

79-8.02D(1) Electrodes for Welding

Ensure electrodes for welding comply with AASHTO/AWS D1.5M/D1.5, current edition and be compatible in strength and composition with the materials joined.

79-8.02D(2) High Strength (H.S.) Bolts, Nuts and Washers

High Strength (H.S.) Ensure bolts conform to ASTM F3125 Grade A325 Type 1. Ensure the recommended nut and washer, listed in the aforementioned specification, is used in conjunction with all high strength bolts, unless noted otherwise. Ensure all bolts conform to the dimensions specified in F3125.

Ensure threads for bolts, nuts, and cap screws conform to the unified thread standards, coarse thread series with a Class 2A tolerance for bolts and Class 2B tolerance for nuts, in accordance with ASME B1.1, unless otherwise specified.

79-8.02D(3) High-Strength Turned Bolts

Ensure turned bolts 1 ½ inches and smaller conform to ASTM F3125, Grade A325, Type 1, or SAE Grade 5, unless otherwise specified on the contract plans. Ensure turned bolts larger than 1 ½ inches conform to ASTM A449 Type 1 unless otherwise specified on the Contract Plans. For this paragraph, specification conformance refers to material, chemistry, and mechanical properties.

79-8.02D(4) Socket Head Cap Screws

Ensure alloy steel socket head cap screws comply with ASTM A574. Ensure stainless steel socket head cap screws are Type 316, with a minimum tensile strength of 80,000, and meet or exceed ASTM F837, Alloy Group 2, Condition CW, unless otherwise specified. Ensure dimensions conform to ASME B18.3.

79-8.02D(5) Hex Cap Screws

Ensure hex cap screws up to and including 1½ inch diameter conform to ASTM F3125, Grade A325, Type 1. Ensure hex cap screws greater than 1½ inch diameter conform to ASTM A449, Type 1. Ensure heavy hex nuts and hardened washers are used with hex cap screws and conform to A563 Grade DH, and F436 Type 1, respectively. Ensure stainless steel hex cap screws are Type 316 with a minimum tensile strength of 85,000 psi and meet or exceed ASTM F593, Alloy Group 2, Condition CW. Ensure locking of nuts, preferably be by use of double nuts. Ensure hole clearances are governed by ASME B18.2.8. Ensure screw length is sufficient to allow a minimum of two threads to extend beyond the nut.

79-8.02D(6) Flat Countersunk Head Cap Screws

Ensure flat countersunk head cap screws conform to ASTM F835. Ensure stainless steel flat countersunk head cap screws are Type 316, with a minimum tensile strength of 80,000 psi, and meet or exceed ASTM F879, Alloy Group 2, Condition CW, unless otherwise specified. Ensure dimensions conform to ASME B18.3.

79-8.02D(7) Stainless Steel Fasteners

Ensure stainless steel for fasteners complies with the preceding paragraphs, unless otherwise specified. Ensure stainless steel fasteners are used in conjunction with stainless steel washers (Type 316) and hex nuts of Type 316 stainless steel with a minimum proof strength of 85,000 psi and meeting or exceeding ASTM F594, Alloy Group 2, Condition CW. Ensure stainless steel pins are ASTM A276, Type 316, Condition S, cold finished.

Tighten stainless steel bolts to produce a tension of 70% of the proof load. Include friction coefficient data for any thread lubricant with installation procedures to confirm torque magnitudes.

79-8.03 CONSTRUCTION

79-8.03A General

Ensure the machinery is finished, assembled, and adjusted in an approved manner using best machine-shop practice. Place the limits of accuracy which are to be observed in machining the work, and the allowances for all metal fits, on the Contractor's working drawings.

Ensure where surface finishes are indicated on the Contract Plans or specified herein, the symbols used conform to ASME B46.1, "Surface Texture". Values of roughness height are specified in micro-inches as an arithmetical average deviation from the mean line. Roughness specified is the maximum value, and any smoother finish will be satisfactory, unless noted by the Engineer. Determine compliance with specified surface roughness by trained sense of feel and by visual inspection of the work compared to standard "roughness comparison specimens" in accordance with the provisions of AMSE B46.1. Ensure values of roughness width and waviness are not specified but are consistent with the general type of finish specified by the roughness height. Flaws such as scratches, ridges, holes, peaks, cracks, or checks will be rejected.

So far as practicable, lay out all work to secure proper matching of adjoining unfinished surfaces. Remedy large discrepancies between adjoining unfinished surfaces to realize proper alignment. Ensure unfinished surfaces are true to the lines and dimensions shown on the shop drawings and are free of all projections and rough spots. Depressions or holes not affecting the strength or function of the parts may be filled in a manner approved by the Engineer.

79-8.03B Mechanical Component Requirements

79-8.03B(1) Shafting and Pins

Ensure rounds and shafts are true, straight, and free from flaws, piping, laps, seams, or cracks. Ensure all shafts have finished ends with a 60-degree lathe center with a clearance hole at the exact center of the shaft. Ensure stepped shafts have fillets finished smoothly to adjacent surfaces without tool marks or scratches. Ensure surface finish for fillets have a maximum roughness of 63 micro-inches according to ASME B46.1 unless a finer finish is required.

Ensure all forged shafts are reduced to size from a single bloom or ingot until perfect homogeneity is secured. Ensure the blooms or ingots, from which shafts or pins are to be made, have a cross-sectional area at least three times that required after finishing. Ensure no forging is done at less than red heat. Ensure forged rounds for shafts and pins are true, straight, and free from any defect.

Ensure all shafts and pins are accurately finished, round, smooth, and straight; and when turned to different diameters, have rounded fillets at the shoulders. Ensure each shaft or pin having a uniform diameter of 8 inches or more and each shaft or pin having several diameters, of which the smallest is 8 inches or more, are bored lengthwise through the center to a diameter approximately one fifth the smallest diameter. Examine the wall of the center bore for cracks and fissures. Shafts and pins exhibiting defects will not be accepted. Ensure shafts that are bored with an inspection hole have their ends prepared for the attachment of a centering device equivalent to the lathe center. Furnish all such devices as part of the work.

Ensure turned, ground and polished shafting straightness tolerance is 0.002 inches per foot for shafts up to and including 1-1/2 inches in diameter and 0.003 inches per foot for shafts over 1-1/2 inches in diameter. Ensure all shafts are free from camber and run without vibration, noise, or chatter at all speeds up to and including at all operating speeds.

Accurately turn, grind, and polish journal bearing areas on shafts and pins with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Ensure the journal bearing area has an 8 micro-inch finish or better. Finish journal diameters to the limits of an ANSI Class RC6 running fit, unless otherwise noted. Ensure bearing seats on shafts with rolling element bearings have a surface finish of 63 microinches, unless otherwise specified by the bearing manufacturer. Ensure fit of rolling element bearing I.D. and shaft are as specified by the bearing manufacturer.

79-8.03B(2) Fits and Finishes

Fits and finishes of machinery parts will be as called for on the contract drawings or as specified in AASHTO, Paragraph 6.7.8. or vendors' recommended specifications, whichever is more rigorous.

The symbols must conform to ANSI B46.1, "Surface Texture", where surface finishes are indicated on the contract drawings or specified herein. Specify values of roughness height in micro-inches as an arithmetical average deviation from the mean line. Roughness specified is the maximum value, and any smoother finish will be satisfactory. Determine compliance with specified surface roughness by trained sense of feel and by visual inspection of the work compared to "Standard Roughness Comparisons" in accordance with the provisions of ANSI B46.1. Unspecified values of roughness width and waviness must be consistent with the general type of finish specified by the roughness height. Reject flaws such as scratches, ridges, holes, peaks, cracks or checks which will make the part unsuitable.

Unspecified surface finishes must conform to AASHTO, Paragraph 6.7.8. Machine mating surfaces to provide an even and true bearing. Highly polish and finish true to the given dimensions surfaces with rotating or sliding contact. Indicate surfaces to be machine-finished on shop drawings by symbols, which conform to ANSI B46.1.

So far as practicable, lay out all work to secure proper matching of adjoining unfinished surfaces. Remedy large discrepancies between adjoining unfinished surfaces to realize proper alignment. Chip or grind unfinished surfaces free of all projections and rough spots. Unfinished surfaces must be true to the lines and dimensions shown on the shop drawings. Fill depressions or holes not affecting the strength or function of the parts in a manner approved by the Engineer.

79-8.03B(3) Keys, Keyways, and Set Screws

Ensure keys and keyways conform to AASHTO MHBDS. Ensure keys for all components are made from cold-finished carbon steel squares or flats that meet the requirements of ASTM A668, Class K, with a minimum tensile strength of 105,000 psi, and minimum yield strength of 80,000 psi, or approved equal.

Keys and keyways must conform to the dimensions and tolerances for square and flat keys of the ANSI Standard B17.1, "Keys and Keyseats," unless otherwise specified. Machine keys for an FN2 side fit (Class 3) and an LC4 fit on top and bottom with keyways in shafts and hubs and a 63 micro-inch finish or better. Cut keyway corners and key chamfers with the fillet radius and chamfer as suggested by ANSI B17.1. Effectively hold all keys in place, preferably by setting them into closed-end keyways milled into the shaft. Round the ends of all such keys to a half circle equal to the width of the key. Keyways must not extend into any bearing. If using two keys, locate them 120 degrees apart. Provide custom keys as necessary for manufactured components to meet the required key fits and finishes.

Do not substitute set screws for keys for transmitting torsion; use them only for holding keys or light parts in place. They will be safety-type headless set screws with cup points set in counterbored seats. Unless otherwise ordered, secure them in place by use of self-locking threads.

79-8.03B(4) Steel Castings

Take all necessary precautions to fabricate the castings free of cracks, cold shuts, shrink holes, blowholes, and porosity. Clean all castings free of loose scale and sand, all fins, seams, gates, risers, and other irregularities must be removed. Neatly cast all unfinished edges of castings with rounded corners and ensure all inside angles have ample fillets.

Ensure steel castings conform to ASTM A148, and the grade is determined by the Contractor.

Ultrasonically test all castings in accordance with ASTM A609, Method A, Quality Level 3. Castings that do not pass this test may be rejected. Ensure all test results, whether positive or negative, are submitted to the Engineer. Test records meeting Quality Level 4 may be considered for weld repair, provided the fabricator submits a procedure to the Engineer for review and approval. Ensure all repair procedures include a means to qualify the repair. Test records meeting Quality Level 5 or higher are cause for rejection and not be allowed for weld repair. Ensure rejection results in the Contractor providing a new casting meeting the acceptance criteria, at no additional cost to the Owner.

Visually inspect all castings in accordance with ASTM A802, Level III. Castings that do not pass this test may be rejected. Ensure all test results, whether positive or negative, are submitted to the Engineer. Test records meeting Level III may be considered for weld repair, provided the fabricator submits a procedure to them for review and approval. Ensure all repair procedures include a means to qualify the repair.

Magnetic particle examine all castings in accordance with ASTM E125. The following level of discontinuities will be acceptable:

<u>TYPE</u>	<u>DESCRIPTION</u>	<u>ALLOWABLE</u>
<u>I</u>	<u>Cracks/Hot Tears</u>	<u>1/4" max</u>
<u>II</u>	<u>Shrink</u>	<u>Degree 3</u>
<u>III</u>	<u>Inclusions</u>	<u>Degree 3</u>
<u>IV</u>	<u>Chaplets</u>	<u>Degree 2</u>
<u>V</u>	<u>Porosity</u>	<u>Degree 1</u>

Dimensions of castings shown on the approved shop drawings will be the finished dimensions. Deviations from the dimensions and the thicknesses of the castings, as shown on the drawings, will not be permitted to exceed such amounts as will, in the opinion of the Engineer, impair the strength of the casting as computed from the dimensions shown. Warped or otherwise distorted castings, or castings that are oversize to such an extent as to interfere with the proper fit with other parts of the machinery, will be rejected.

79-8.03B(5) Weldments

Ensure steel for weldments and miscellaneous components is ASTM A709 Grade 50, with a minimum thickness of 1/2", unless otherwise specified, fine grain practice is mandatory, and always weldable grades as designated by applicable ASTM standards. Ensure welding materials and methods conform to the AWS Code D1.5M/D1.5, current edition.

Fabricate weldments for support of machinery as a single fabricated unit. Use initial steel plates of sufficient thickness to provide machining allowances toward obtaining the finished dimensions shown on the Plans.

Treat all welded machinery and weldments that support machinery as main members, all welds as subject to tension and stress reversal, and as joining primary components. Clip stiffeners to avoid overlapping of stiffener welds with main member welds. Avoid welding in two planes, when welding all around.

Use suitable welding fixtures such that distortion of the work will be a minimum. Perform stress relieving of weldments after welding and prior to final machining in accordance with AASHTO/AWS D1.5M/D1.5. Submit stress relieving procedures. Submit certifications following stress relief.

Finish all machined surfaces of weldments to a flatness tolerance of 0.005 inch, unless specified otherwise in the Plans. Finish machinery bearing surfaces to parallelism tolerance within 0.005 inch of the other bearing surfaces on the same unit, and also to the bottom of the base plate. For weldments supporting machinery on shims, finish machine the height of the weldments, as measured from the bottom of the base plate to the top of the bearing surface, to a tolerance of +/-1/32 inch. Grind all exposed edges of weldments to a chamfer or radius to eliminate sharp edges and burrs. Unless noted otherwise, provide a minimum 1/2-inch radius on the corners of weldment base plates which will be placed against concrete/grout or steel supports.

Provide lifting lugs on each weldment for lifting and handling. Ensure that lugs are located to provide a balanced lift and have a minimum lifting capacity of five times the weight of the weldment with machinery installed.

Drill and tap leveling screws through the weldment base plate for field leveling of all weldments that are mounted on concrete. Use leveling screws with adequate capacity to support the weldment and any other construction loads anticipated to be applied prior to the application of grout under the base plate.

Coat mounting surfaces immediately following finish machining with an approved temporary protective coating that prevents oxidation. Clean base plate surfaces to be in contact with grout to SSPC SP-7.

79-8.03B(6) Shims

Include shims for all machinery components for leveling and alignment of equipment. Ensure shims are stainless steel, ASTM A240 Type 316, neatly trimmed to the dimensions of the assembled parts, and drilled for all bolts that pass through the shims. Do not use slotted shims, unless noted otherwise on the contract plans. Ensure that in general, total shim thickness available is no less than equal to twice the nominal thickness shown on the contract plans, and sufficient varying thicknesses are furnished to secure 0.010-inch variations of the shim allowance including one shim equal to the full allowance. Ensure the Contractor provides shims with less than 0.010-inch variations if required to meet proper machinery installation alignment tolerances. Place shims to provide full contact between machinery and machinery supports. Show all shims shall in detail on the shop drawings. Individually pack shim packs to prevent damage from handling during shipment to the project

site. Clearly mark packaging with the plan sheet number and item number of the part for which the shim pack was fabricated.

Provide tapered shims as necessary to achieve proper trunnion bearing alignment. Provide full contact across the tapered shim mounting surface with the bearings and the bearing supports. Ensure tapered shim plates have a minimum thickness of 1/4" inch. Ensure tapered shims have a multidirectional lay top and bottom and have all surfaces machine-finished to 125 micro-inches. Ensure tapered shim bolt holes are drilled and reamed in the field, after final alignment, to the same fit as the connected components (and may be oversized 1/16" to aid in installation).

79-8.03B(7) Hubs and Bores

Finish the hubs of all gears and couplings on both faces where the hub face performs the function of a collar to prevent shaft movement. Bore the hubs concentric with the rims of gears or with the outside of couplings. Ensure that unless otherwise noted or recommended by the manufacturer, all other hubs have a 32 micro-inch finish or better for 2 inch or smaller bore, or a 63 micro-inch finish or better for a bore larger than 2 inches. Ensure all hubs have an ANSI Class FN2 medium force fit on the shafts unless otherwise specified.

79-8.03B(8) Gears

Cut the teeth of all gears from solid rims or blanks. Make gears out of forged steel with isotropic grain structures. Rolled plate will not be acceptable. Ensure the sides and peripheries of all gears and pinions are finished, and the pitch circle for the rack and pinion is scribed on both sides not less than 0.02 inches deep, with a V-pointed tool. Ensure the working surfaces of all gear teeth are true to the proper outline, accurately spaced on the true pitch circle, exceptionally smooth, and free from plane or milling-cutter ridges. Remove cutter burrs from all edges of the teeth, and round the top edges of all teeth to a 1/32-inch radius.

Except as otherwise provided herein, cut and mount all gears to meet requirements for accuracy of the ANSI/AGMA Standard 2000-A88 (or most recent replacement standards), Gear Classification and Inspection Handbook: Tolerances and Measuring Methods for Unassembled Spur and Helical Gears. State the AGMA Quality Number on the applicable shop drawings. Ensure open gearing conforms to minimum quality number of AGMA Qv 8. Ensure gearing in enclosed gear reducers conforms to minimum quality number of AGMA Qv 10. Ensure pinion gear and rack gear teeth are 20-degree involute, full depth, cut teeth.

79-8.03B(9) High-Strength Turned Bolts

Ensure turned bolts conform to AASHTO and are high-strength turned bolts. Finish the bodies of turned bolts to 63 micro-inches or better, as defined by AASHTO. Threads for the turned bolts and nuts must conform to the Unified Thread Standards, coarse thread series with a Class 2A tolerance for bolts and Class 2B tolerance for nuts, in accordance with ANSI B1.1, unless otherwise specified. Manufacturers designate turned bolts by their nominal thread size. The turned bolt body must be 1/16 inch larger in diameter than the nominal size specified and must have an LC6 fit with reamed holes. Bolt head and nut bearing surfaces must be flat and square with the axis of the bolt holes. Spot face bolt head and nut bearing surfaces if necessary. Unless otherwise noted, the Contractor may sub-drill (in the shop) bolt holes in machinery parts required for connecting to supporting steelwork smaller than the turned bolt diameter and must ream them together with supporting structural steel either during assembly or at erection after the parts are correctly assembled and aligned. Provide positive type locking. Double heavy hex nuts are preferred. Where not using double heavy hex nuts, use heavy hex and jam nuts. Submit alternate locking methods to the Engineer for approval. Install turned bolts with a hardened plain washer meeting ASTM F436 at the head and nut ends.

79-8.03B(10) Anchor Bolts

Ensure anchor bolts conform to AASHTO.

79-8.03B(11) Bushings and Liners

Ensure self-lubricating (maintenance free) metallic bushings are standard products of a manufacturer and can be lubricated with grease. Ensure bearings are the product of a manufacturer who has had bearings, of comparable size, type, and materials, in successful (defect free) service for at least 10 years. Submit a record of the project history documenting the successful service. Ensure the bushing manufacturer submits a letter certifying the use of the bushing for the selected application.

Ensure bronze bushings are made of ASTM B22, Alloy C91100. Grease lubricate all bronze bushings and groove the inside diameter for lubrication through the bolts or shafts, at the centerline of the bushing, or fed

from a central housing cavity between two bushings. Use of "Double Oval" grooving is preferred, unless otherwise shown on the plans. Ensure all grease grooves are machine-cut and smooth. Ensure the corners of all grooves are rounded to a radius of not more than half the width of the groove or as shown, with all radii tangent to adjoining surfaces. Remove small inequalities by chipping and filing.

Ensure brass liners having a total thickness of 1/4" consisting of one solid piece 1/8" thick and one laminated piece 1/8" thick with 0.003" laminations provide the proper fit between shafts and bushings at split pillow block housings. Ensure liners conform to AMS-DTL-22499 Comp 2.

79-8.03B(12) Pillow Block Housings

Provide pillow blocks with turned bolts (or studs) for bearing caps that meet or exceed the requirements of ASTM A449. Ensure pillow block caps include a tapped hole with a lifting eye-bolt of sufficient capacity to carry twice the estimated weight of the bearing assembly. Design the pillow blocks to withstand design radial and axial loads including uplift. Key or dowel assemblies together in split bearing housings to establish and maintain the bore for the bearing and to eliminate shear loads on the cap bolts. Equip bearing housings with lube fittings. Use the following minimum materials with higher strength materials substituted as required by analysis:

1. Bearing Housings: Carbon Steel ASTM A36
2. Cap Bolts: High-Strength Turned Bolts, ASTM A449
3. Hex Head Cap Screws: ASTM F3125, Grade A325, Type 1

Ensure bearing housings are painted with the manufacturer's premium, high performance, epoxy paint system recommended for outdoor applications in harsh marine environments, which must be submitted to the Engineer for approval. Ensure that if the manufacturer does not have a recommended high performance paint system, the bearings are painted according to the paint system and requirements specified in this specification. See painting requirements in this specification for more details and color requirements.

79-8.03B(13) Couplings

Use gear-type, full-flexible (double engagement) couplings or semi-flexible (single engagement) couplings with floating shafts to connect all machinery components, unless otherwise noted. The use of Grid-type couplings is not permitted. Ensure the couplings are made of forged alloy steel, have exposed bolts, curved face teeth, and provide for at least a 3/4-degree misalignment per gear mesh. Limit installation misalignment per the manufacturer's alignment tolerances for installation.

Ensure gear-type couplings are the product of a manufacturer who has had gear-type couplings, of comparable size, type, and materials, in successful (defect free) service for at least 10 years. Submit a record of the project history documenting the successful service. Ensure coupling hubs are bored by the coupling manufacturer to the required size and tolerances, including keyways, and each hub shipped to the proper location for installation on its shaft by the manufacturer of the connected component or by the Contractor's machine shop.

79-8.03B(14) Instrumentation Drivetrain Couplings

Ensure instrumentation drivetrain couplings are disc type couplings with high torsional stiffness or stainless-steel beam type couplings designed for precise motion control. Ensure instrumentation drive couplings require no maintenance.

Ensure couplings are finish bored and have keyways cut to the dimensions and tolerances established on the approved shop drawings for the required fit at shop installation with their respective shafts. Ensure the required fit between the coupling hub and the mating shaft are as per the coupling manufacturer's recommendations. Ensure the required fit between the keyway and key per ANSI B17.1 Class 2. Dimension fillets on all keyway corners as per ANSI B17.1.

79-8.03B(15) Enclosed Speed Reducers

Ensure speed reducers are designed and manufactured by a manufacturer with at least ten years' experience in the design, fabrication, testing, installation and startup of gear boxes for movable bridge systems of comparable size and type. Submit a record of the project history documenting the successful service. The Owner may send an inspector to witness shop testing and to verify compliance of the reducer(s) and its components, prior to shipment of the reducers to the field.

Ensure the speed reducers are designed in accordance with AASHTO and the current AGMA Standards for enclosed industrial gear reducers. Provide results of mechanical testing of all materials. Perform all inspection

and testing as recommended by AGMA 923-B05 to demonstrate compliance with metallurgical specifications of the selected material grade. In all cases where the design Standards for gear boxes or the Specifications are in conflict with another, design for the more conservative standard.

Ensure the reducers have welded steel housings with adequate inspection openings to permit easy inspection of all gears after installation. Stress relieve welded steel housings by heat prior to final machining. Provide dowel pins at all parting seams for accurate gear and bearing alignment. Extend the reducer bases sufficiently past the body of the reducers to allow for drilling and reaming of the mounting bolt holes, and for bolt installation from above the base. Provide a minimum edge distance of 1.35 times the bolt diameter to the centerline of the mounting bolt on the mounting pad. Provide adequate thickness and width at the base to reduce the stress on mounting bolts. Provide large, rugged lifting lugs for each housing section and lifting lugs capable of lifting each assembled reducer. Ensure the internal and external surfaces of the gear box have an anti-corrosive finish.

Provide removable inspection covers on the housings to facilitate viewing of all gears, bearings and other internal devices. Ensure the location of inspection ports on the sides of the reducers is above the oil level, so that oil draining is not required for inspection. Attach inspection covers with stainless steel hardware. Provide each inspection cover with seals that do not require replacement when access ports are opened. Provide handles on each inspection cover.

Provide breathers that are moisture trap, desiccant types with a color indicator to show the desiccant moisture state. Locate moisture-trap breathers the maximum oil levels in all positions of the reducer during operation, and provide piping entering the unit at the highest point possible.

Mount oil level indicators in locations that can be easily viewed by maintenance crews. Provide a graduated sight gauge. Vent the indicator back to the case. Provide sight gauges of rugged construction and protect them against breakage.

Provide an oil drain for each reducer. Locate oil drains in an easily accessible location based on the final configuration of the machinery layout. Fit the oil drains with a stainless steel ball valve with a pressure-temperature rating of 2000 psig and 100° F, at the lowest point possible. Provide a plug on the open end of the valve. Provide a hand-operated lever for the drain that can be locked in the closed position.

Provide two oil sampling cocks, one located at the lowest level of oil and one just below the upper oil level, in accessible positions on the reducers.

Locate grease fittings for grease lubricated bearings at readily accessible locations. Provide internal seals between the bearing housing and the gear oil to prevent interaction between grease and oil.

Ensure the shaft seals incorporate a two-stage sealing arrangement with intermediate grease purge between the seals. Ensure the outer seal and any retainer are replaceable without removal of couplings, brake wheels or other machinery components. Ensure the housings are leak-proof and tested in the shop for leakage. Ensure the seals are fitted to the gearbox by the gearbox manufacturer. Wetness of the seal area is acceptable, but oil drips are not acceptable.

Ensure the low and high-speed shaft extensions are of such length and diameter that they may be turned and key seated for coupling hubs, brake wheels and other machinery components. Ship all machinery components fitted onto the reducer shafts to the reducer manufacturer for assembly on the shaft extensions.

Provide reducers with a permanent AGMA nameplate stating the horsepower rating, speeds, ratio and thermal rating. Ensure the manufacturer's nameplate includes the manufacturer's name, address, model number, and serial number (nameplate of distributing agent will not be acceptable). Ensure the nameplate is laser engraved type 316 stainless steel.

Provide automatic lubrication of the gears and bearings when the unit is in operation, using a bath lubrication system. Ensure all components in the gearbox, which require lubrication, are partially submerged in an oil bath. Ensure a splash lubrication system is permitted only when the configuration of gears and bearings prevent bath lubrication. Ensure splash lubrication systems continuously lubricate all gears and bearings properly when the unit is in operation. Design splash lubrication systems such that equal lubrication is supplied to each internal component for both directions of operation. Oil feed troughs may be used to supply oil to bearings and gears, which are above the bath. Provide lubricant meeting viscosity and other requirements of AGMA 9005-E02.

Industrial Gear Lubrication. Ensure pressurized lubrication systems for gear boxes are not permitted unless specifically approved by the Engineer. When a pressurized lubrication system is required for the reducer, provide a redundant lubrication system so that both systems operate concurrently. Provide a contact for remote alarm indication in case of a lubrication system malfunction.

Enclose the combined assembly of gears, shafts and bearings by a housing of such design and construction as to provide the necessary rigidity required for proper gear alignment. Ensure the housing maintains alignment under rated internal and external loading.

Paint reducers with the manufacturer's premium, high performance, epoxy paint system recommended for outdoor applications in harsh marine environments, which includes a prime coat along with two coats of epoxy paint and is submitted to the Engineer for approval. See painting requirements in this specification for more details and color requirements for the gearboxes.

Ensure that prior to fabrication, the manufacturer submits to the Engineer for review, a complete set of calculations demonstrating adherence to design criteria presented herein including AGMA ratings for gear sets, bearing ratings, and shaft sizing.

Ensure the manufacturer submits certified prints for each gearbox showing:

1. All external mounting dimensions including shaft sizes, bores, and keyways
2. Ratings that will appear on the nameplate
3. Location of all lubricant connections
4. Section views, with part numbers for each component

Ensure the Contractor submits shop drawings showing interface with other equipment, and including the following:

1. Main drive gear boxes with bill of materials
2. Ratios, dimensions, construction details, and agma ratings
3. Installation, operation and maintenance manual sheets
4. Operational experience record for model supplied
5. Product data for all components
6. Certified test data for all factory tests and as-built plans

79-8.03B(16) Drip Pans

Install drip pans under areas prone to lubricant leakage/purge (main counterweight rope grooves, main counterweight trunnion bearings, shaft seals, etc.) Ensure pans are constructed of 12 gage minimum Type 316 stainless steel and are of a welded construction positively attached to machinery supports, grating or anchored to the floor as appropriate.

79-8.03B(17) Machinery Guards and Covers

Equip the machinery house with machinery guards to cover all rotating components in the machinery house including: shafts, gears, and couplings. Construct guards of Type 316 stainless steel, expanded sheet, flattened mesh, conforming to ASTM F1267 Type II, ½ x No. 16, or approved equal, stiffened and supported with Type 316 stainless steel sheet metal along all edges and intermediately as necessary to be rigid. Provide easy access at maintenance points by hinged or otherwise two-piece access. Ensure the guards are removable if additional access is required. Ensure supports and fasteners are Type 316 stainless steel. Locate the machinery guard supports to minimize interference with access areas. Ensure the Contractor submits machinery guard details for approval.

Use rubber edge trim with metal core to provide protection on edges of covers and guards, especially where chafing of electrical wiring could occur.

Supply motor and machinery brake covers by the brake manufacturer as described in the Operating Machinery Special Provision.

79-8.03B(18) Welding

Ensure welding required for machinery complies with AASHTO/AWS D1.5M/D1.5, current edition. Ensure the Contractor submits a schedule of the proposed stress relief heat treatment to the Engineer for approval. Include in the schedule a description of the part and an explanation of the proposed heat treatment, including the rate of heating, the soaking temperature, the time at the soaking temperature, the rate of cooling, and the

temperature at which the part is to be withdrawn from the chamber. Soaking times of less than one hour are not permitted. Test all welds used to fabricate machinery completely by ultrasonic inspection using the methods given by ASTM E164, according to AASHTO/AWS D1.5M/D1.5 for tension members, unless noted otherwise.

Ensure all structural welds are complete joint penetration (CJP) welds unless otherwise noted or shown on the Contract Plans. No feather edges allowed on weldments. Weld all free edges of stiffeners, webs, and gussets.

Ensure all welding is done by welders with an AWS certification applicable to the work.

Ensure welding for stainless steel conforms to AWS D1.6/D1.6M.

Ensure welding for aluminum conforms to AWS D1.2/D1.2M.

Submit all weld procedures and welding qualifications prior to the start of work.

Ensure that, unless otherwise specified, welds meet minimum weld sizes per AASTHO/AWS D1.5M/D1.5. Ensure the Contractor selects preheat and soak times accordingly to provide the required heat input and submits this to the Engineer for approval.

Ensure all fillet welds are 100% magnetic particle tested, and all groove welds are 100% UT tested.

79-8.03C Lubrication Schedule

Ensure the Contractor prepares and furnishes a lubrication schedule.

79-8.03D Types of Lubricants

Ensure lubricant compounds furnished are recommended and certified by their manufacturer for the use and requirements called for. Ensure lubricants are recommended for use year round with consideration to ambient temperature ranges that will be experienced by the various components. Synthetic lubricants may be proposed but must be compatible with all seals and sealing compounds that may be exposed to the lubricant. Ensure the Contractor furnishes a copy of the certification.

79-8.03H Tools and Equipment

Ensure the Contractor supplies all equipment necessary to perform the work specified in the contract.

Equip the maintenance room in each pier with the following tools and lubrication equipment:

- 1 each - Box and open-end combination wrenches made of high-grade, drop-forged steel, with chrome-plating over nickel finish, to fit bolt heads, nuts, and cap screws from 1/4 to 1-1/4 inches, inclusive.
- 1 each - Single-end, angle wrenches of high-grade, drop-forged steel to fit all bolt heads and nuts larger than 1-1/4-inch size actually used in the job.
- 1 set - Socket wrenches, as required, to supplement the wrenches in previous items for dismantling flexible couplings.
- 1 each - 12-inch adjustable wrench.
- 1 set - Alloy-steel hex wrenches for all socket-head screws.
- 1 each - 8-inch and 10-inch screwdrivers with solid, hardened steel square shanks, and insulated composition handles.
- 1 each - 2-pound ball-peen hammer.
- 2 each - Hand lubrication guns, screw type, 12-ounce capacity, for each size lube fitting used.
- 1 each - Load pump for 25-pound capacity pail for each type gun furnished.
- 1 each - Grease transfer pump, complete with hose and fittings for 120-pound drum.
- 1 each - Of any other size wrenches and special tools for lubrication gun as required by the machinery manufacturer.

Mount the set of tools, plus grease guns, in a sufficiently sized 12-gauge minimum steel cabinet provided by the Contractor with hinged doors and locks. Ensure the cabinet is welded steel construction, with all outside welds continuous and ground smooth. Install suitable clips in the cabinet for holding each tool in place. Label the space of each wrench with the wrench opening, and the spaces for other tools with the tool name. Ensure the Contractor also furnishes a steel cabinet similar to the tool cabinet. Place both cabinets in the machinery room in each pier. Ensure the Contractor also furnishes a suitable work bench (60" long), machinist's vise, and two portable steel tool boxes for the machinery room. Ensure the tool boxes are approximately 8-1/2" by 9" by 30".

79-8.03I Span Assembly and Operation

Shop assemble machinery components mounted on common bedplates with turned bolts to verify their correct fit prior to shipment. Match-mark any components requiring selective assembly for future assembly. Disassemble components not mounted on a common base for shipment.

Ensure that after the span operating machinery (drive motors, motor brakes, couplings, etc.) has been sub-assembled in the shop, the entire drive train is driven under power forward and backward sufficiently to demonstrate that all shafts run freely but without unnecessary looseness. Ensure that parts have the minimum amount of play consistent with their free operation where not otherwise specified.

Main drive train: After alignment and bolting into place in the shop, test run the assembly in place for a minimum of four hours (two hours each direction) during which all bearings are monitored for noise, temperature, and lubrication. Test run the main motors in place for a period of 30 minutes in each direction. Check the reducer housings for leaks at bearing covers, seals, inspection covers, oil drains, bolts, and welds. Ensure the noise level of each reducer does not exceed 90 db while operating at maximum speed when the microphone is located 3 feet from the reducer housing.

Make these tests and calibrations in the presence of the Engineer or their representative(s). Ensure the Contractor provides the Engineer with written notice 10 days prior to the date the operational tests and calibrations will take place.

Ensure no equipment is shipped to the field without being calibrated and tested.

Ensure the various parts of units or groups, such as gear reducers, shaft couplings, and bearings, before leaving the shop are marked according to mating, location and correct relation to facilitate reassembling at the bridge site. Make stamp markings in areas of the part or assembly that are not subjected to significant stress during operation.

79-8.03J Delivery, Storage, and Handling**79-8.03J(1) General**

Deliver all components and materials to the site in accordance with the approved schedule of work. Ensure any special provisions used for material handling are provided by the Contractor. Ensure no equipment is shipped to the field without being successfully tested and calibrated.

Do not ship counterweight sheaves with the trunnion bearings installed unless permission to do so has been granted by the bearing manufacturer, in writing, and submitted to the Engineer for approval.

79-8.03J(2) Delivery

Properly package and protect components and (from weather, dirt, and all other injurious conditions during manufacture, shipment, and while awaiting erection) from initial shipment until the time of installation.

Clean all machinery of dirt, chips, grit and all other injurious material prior to shipping.

Ensure prior to shipment from the manufacturer's and/or fabricator's plant or plants, the Contractor prepares the various elements for shipment. Securely mount all large, bulky and/or heavy items on skids or pallets of ample size and strength to facilitate loading and unloading. Craft skids or pallets for protection during shipment and storage. Box all small parts in sturdy wood or heavy corrugated paperboard boxes. Securely attach a packing list enclosed in a moisture proof envelope and indicating the contents of each such box to the outside of the container. Ensure the skid/pallet mounting and boxing is done in a manner which will prevent damage to the equipment during loading, shipment, unloading, storage and any associated and/or subsequent handling. Provide weatherproof covers during shipment to protect any and all items shipped in open railway cars, trucks, or barges. Furnish any eyebolts, special slings, strongbacks, skidding attachments or other devices used in loading the equipment at the manufacturer's and/or fabricator's plant or plants for unloading and handling at the destination.

Coat finished and unpainted metal surfaces that would be damaged by corrosion with a .030" minimum film thickness, as soon as practicable after finishing, of No-Ox-Id, A-Special, as manufactured by San-Chem Company, Chicago, Illinois, or approved equal. Remove this coating from all surfaces prior to lubrication for operation and from all surfaces prior to painting after erection. Ensure that if the anti-rust coating on any part becomes compromised prior to part installation, the coating is restored immediately.

Protect shaft journals that are shipped disassembled from their bearings during shipment and before erection by a packing of oil-soaked cotton gauze secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached; an alternate method may be submitted for approval. Take every precaution to ensure that the bearing surfaces will not be damaged and that all parts arrive at their destination in satisfactory condition.

Ensure all shipping units have lifting eye bolts or lifting holes properly sized for safe working loads and located to provide a balanced lift.

Ship all wire ropes on reels, the diameter of which are not to be less than 26 times the diameter of the ropes, which are mounted on skids or otherwise crated for protection during shipment and storage.

79-8.03K Erection

Do not commence erection work until the required items have been completed and approved for installation, and until preparations by others where required have been satisfactorily completed.

Ensure the Contractor provides personnel and supervising engineers familiar and experienced in the installation of movable bridge machinery, especially for vertical lift bridges. Ensure the Contractor provides all the precision equipment that may be required for the proper and accurate installation of the machinery.

Ensure that prior to erection, all finished surfaces, which were coated by a rust-inhibiting coating, have their coatings removed with gasoline, benzene, or other approved solvent. Ensure that while machinery parts are being erected, and work is interrupted, they are covered by a sound tarpaulin or other durable waterproof covering. Prevent soil and waterway contamination by appropriate containment. Collect and dispose of waste solvents, coating, and expendables per state and federal regulations.

Ensure the machinery: motors, reducers, brakes, bolsters, shafts, couplings, ancillary electrical equipment connected to the operating machinery, sheaves, trunnion bearings, bearing bolsters, and span locks, is erected and adjusted by personnel with the Construction Millwright/Industrial Mechanics certification. Ensure representatives of the machinery manufacturers are present during final assembly. Provide them with all necessary precision measuring and leveling instruments that may be required. Erect the machinery with exactness so the various parts are truly aligned in their proper positions and, when entirely assembled, will operate smoothly without binding or undue looseness of the components.

Erect all parts of the machinery in accordance with erection marks and match-marks. Ensure when the final position of the machinery will change upon application of the full dead load, the final adjustments are made after the dead load is fully applied. Before final drilling or reaming, adjust all parts to exact alignment by means of shims furnished for each part. Ensure that after final alignment and bolting, all components operate smoothly.

Ensure bolt holes in structural steel for connecting machinery with turned bolts are, in general, drilled from the solid after final alignment of the machinery. Sufficient erection holes, sub-drilled 1/4 of an inch undersize for temporary bolts, may be used for erection and alignment of the machinery. Ensure that when the machinery is aligned in its final position, full-size holes for the permanent turned bolts are drilled and reamed; full-size bolts installed; and the temporary bolts removed.

Ensure that torques for bolts are proportioned to their strength and are indicated on the erection drawings.

Torque machinery mounting bolts to 70% of their proof load value published in the applicable ASTM Standards. Include friction coefficient data for any thread lubricant with installation procedures to confirm torque magnitudes.

Ensure torques for double nuts are as follows: If a jam nut is used, place the jam nut on the bolt first. Holding the head of the bolt, torque the first nut to 50% of the target torque. Place the second nut on top of the first nut. Holding the first nut, torque the second nut to 100% of the target torque.

Throughout the installation, adjust or tighten bolts and nuts only with wrenches that fit; tightening with chisels and hammers will not be permitted.

Conduct installation and alignment of all mechanically connected machinery and electrical equipment under supervision of the machinery manufacturer's field engineer.

Ensure that the motors, reducers, brakes, bolsters, shafts, couplings, ancillary electrical equipment connected to the operating machinery, sheaves, trunnion bearings, bearing bolsters, and span locks are assembled, erected, aligned, and adjusted at the bridge site under the direct and continuous supervision of the Engineer, to whom the Contractor shall afford every opportunity and facility to satisfy himself that the work is being done in accordance with the contract plans, specifications, and acceptable construction practices.

79-8.03L Field Inspection and Testing

Perform all field testing and alignment verification in the presence of the Engineer. Give the Engineer at least two weeks' notification prior to all testing.

Recheck alignment of all machinery after all connections and drives have been installed and in operation for a minimum of 10 lift span openings/closings.

79-8.03L(1) Operating Machinery

During final installation, lower all machinery weldments onto the machinery room floor and adjust to be level. Assemble all span drive machinery complete as to all shafts, couplings, bearings, brakes, gearboxes, operating drums, operating rope deflectors, operating rope idlers, and operating rope takes ups are aligned to within the manufacturer's recommended installation tolerances. Make adjustments with stainless steel shims. Ensure all secondary gear reducer output shaft couplings are then uncoupled with the operating drums. Lock the span in the seated position during the entire time the secondary gear reducer output shaft couplings are uncoupled. Energize each drive motor to operate the machinery for 30 minutes in each direction. Check gearbox and reducer housings for lubrication leaks at bearing covers, seals, inspection covers, oil drains, bolts and welds. Ensure the noise level of each gearbox and reducer does not exceed 90 dB while operating at maximum speed when the microphone is located 3 feet from the housing. Ensure the temperature rise of any component does not exceed 100 degrees F over ambient.

Field-verify the motor and machinery brake torque setting so that it is within +10% and -0% of the factory set torque. Adjust the setting if needed and demonstrate conformance with a manually operated torque wrench or other proposed verification method.

79-8.03L(2) Span Locks

After mounting and adjusting each lock assembly, field test each one by operating through not less than 3 cycles while the span is in the closed position. Record the gearmotor current on all phases during the test operations. Ensure the average motor current draw does not exceed 75% of the motor's rated full load amperes.

Operate span lock assemblies during the electrical sequence testing performed under the Bridge Control System specification and Bridge Electrical Testing specification.

79-8.03M Span Balance

79-8.03M(1) Preliminary Span Balance

Ensure that after all construction on the lift span and/or counterweight have been completed with the counterweight ropes installed and preliminarily tensioned, and prior to any use of span operating machinery to raise or lower the lift span, the Contractor determines the preliminary balance conditions of the lift span, per corner, by utilizing calibrated hydraulic jacks mounted adjacent to the bridge bearings. Ensure the Contractor submits, to the Engineer, their methods and calculations for mounting the hydraulic jacks. Ensure calculations are signed and sealed by a Professional Engineer licensed to practice in the State of California. Ensure the Contractor submits jack calibrations.

Ensure that if the results of the preliminary balancing determine that the bridge balance is outside of the acceptable construction balance condition, the Contractor coordinates with the Engineer the means and methods to bring the bridge into an acceptable balance.

79-8.03M(2) Strain Gage Balancing

Ensure that the Contractor is responsible for determining the final balance conditions of the lift span, per corner, by utilizing the strain gage procedure described below. Perform strain gage balancing of the lift span by the Contractor after all construction is completed, including the main motor control system, and after preliminary balance adjustments to the span and/or counterweight have been made. Exercise the lift span through a minimum of 3 full operating cycles prior to strain gage balance testing.

Mount two bi-axial strain gage rosettes on machinery shafts at each corner of the bridge, configured in such a way as to cancel the effects of bending, so that only torsional strain in each shaft is being measured. Continuously measure strain in each shaft simultaneously by a data acquisition system. Simultaneously record the shaft strain from all four corners and the lift height of the bridge by the same data acquisition system.

Ensure that prior to performing strain gage measurements, the Contractor submits full documentation of the proposed procedure, including instrumentation equipment, strain gage mounting and wiring arrangements, method for zeroing static torque, and specific formulas and equations to be utilized for data analysis. Completely detail the method of measuring and determining lift height in this documentation. Submit this documentation to the Engineer for review and approval.

Ensure that prior to recording strain, the strain readings are zeroed and all static torsional loading is relieved from the machinery. Ensure the Contractor submits the proposed procedure to relieve the static torque to zero strain gages.

Take strain gage measurements only on a dry, calm day, with wind loads less than 10 mph, when there is no extraneous equipment, debris, rainwater, ice, snow, or other material on the bridge that would affect the balance of the span.

Test the lift span through at least three (3) complete operational cycles powered by a main motor and maintain a permanent record of each test.

Ensure the Contractor submits a report of the results of the balance determination. From the strain data, compute shaft torque and bridge imbalance, per corner, and plot against feet of lift from full closed to full open, and from full open to full closed. Include a plot of raw strain data against lift height. Include a discussion on the peak operating torques as a percentage of the full load motor torque (when they occur and their magnitude) and system friction in the results presentation.

Initial balancing establishes the existing balance baseline for use in the balance spreadsheet. If the results of the initial balancing determine that the bridge balance is outside of the acceptable balance condition, the Contractor coordinates with the Engineer the means and methods to bring the bridge into an acceptable balance. Perform final balancing to verify that an acceptable final balance has been obtained after the adjustments.

Ensure that if the final balancing results indicate that an acceptable final balance condition has not been obtained after the adjustments have been made, the Contractor makes additional adjustments and repeats the balance testing as required until the desired balance conditions have been achieved.

Ensure additional balance weights are furnished by the Contractor as required.

Ensure the testing and all balance calculations are performed by a Professional Engineer licensed to practice in the State of California. Ensure the Contractor provides evidence of successful strain gage balancing experience on a minimum of three (3) vertical lift bridges within the previous five years. Submit a complete test procedure, along with the resume of the Professional Engineer conducting the tests, for review and approval by the Engineer prior to the initial balancing test.

Include the following in the test procedure:

- Test method
- List of equipment
- Sample calculations
- Torque zeroing method
- Report format

Ensure that after the balance tests have been completed, the Contractor submits a formal report signed and sealed by the Professional Engineer who conducted the tests. Include the following in the report:

- Introduction
- Test procedure and Equipment
- Method of analyzing recorded data
- Presentation of results
- Conclusions

- [Calculations](#)
- [Graphical representation of torque, strain, and span balance plotted against lift height](#)

Balance Requirements:

Adjust the balance of the lift span to meet the following requirements (all reactions listed are dead load only, no live loading):

- During Construction, Bridge Operation Not Permitted. Bridge is in the Closed Position, with Span Locks Engaged:
The lift span is span heavy, with a minimum positive reaction at each end of 5,000 lbs with the bridge in the closed position.
- During Construction, Bridge Operation Permitted:
The lift span is span heavy in the closed position, with a positive reaction at each end between 20,000 lbs and 28,000 lbs.
- Final Balance Condition of Bridge Following Construction:
The lift span is span heavy in the closed position, with a positive reaction at each end between 26,000 lbs and 28,000 lbs.

79-8.03M(3) Operating Machinery Indexing

The Contractor is responsible for properly indexing the operating machinery. This work includes determining the operating machinery load sharing, per corner, by utilizing the strain gauge testing procedure described above for strain gage balancing and ensuring proper lift span live load bearing seating. Ensure strain gage indexing of the operating machinery is performed by the Contractor after all construction is completed, including the main motor control system, and after final lift span balance conditions have been achieved (all balance adjustments completed). Strain gage data obtained during the final lift span balance verification testing, as described above, may be used to analyze the operating machinery load sharing torques. Exercise the lift span through a minimum of 3 full operating cycles prior to strain gage testing for machinery indexing.

Ensure the Contractor adjusts lift span live load bearing shims along with indexing the machinery to ensure that all four bearings are fully seated when the lift span is in the closed position and the lift span and counterweights remain level. Ensure the Contractor verifies that proper roadway and sidewalk height alignment to the approach is maintained with any lift span live load bearing shim adjustments.

Ensure that as part of the index testing, the Contractor operates the bridge to full open then during the bridge closing operation, the lift span is stopped approximately 1 ft. above the fully seated position. Measure clearances between the lift span mounted live load bearing and pier mounted base plates at all four corners. Check levelness of the lift span and counterweights. Release the brakes, re-measure the clearances, and recheck lift span and counterweight levelness, then, the bridge can be fully seated, and clearances measured at all four corners. Release the brakes and re-measure clearances at all four corners. Repeat the cycle of lifting the bridge, then measure the clearances a total of three times.

Ensure that prior to performing machinery index testing, the Contractor submits full documentation of the proposed procedure, including method of measuring and determining machinery indexing and method of correcting machinery indexing, if necessary. Submit this documentation to the Engineer for review and approval.

Ensure the Contractor submits a report of the results of the operating machinery index determination. From the strain data, compute and plot shaft torque per corner against feet of lift from full closed to full open, and from full open to full closed. Include a plot of raw strain data against lift height. Ensure that a discussion on the operating machinery load sharing, per corner, as well as the live load bearing clearance measurements is included in the results presentation.

If the results of the index testing determine that the operating machinery is outside of the acceptable index conditions, ensure the Contractor coordinates with the Engineer to determine the means and methods to bring the machinery into acceptable load sharing with adjustments to the couplings and live load bearing shims. Perform final index testing to verify that the acceptable load sharing and lift span seating conditions have been obtained after the adjustments.

Ensure that if the machinery index results indicate that acceptable indexing of the operating machinery, per corner, has not been obtained after the adjustments have been made, the Contractor makes additional adjustments and repeats the index testing as required until the desired load sharing conditions have been achieved.

Ensure the Contractor performs all work required for operating machinery indexing.

Ensure the testing and all indexing calculations is performed by a Professional Engineer licensed to practice in the State of California. Ensure the Contractor provides evidence of successful strain gage balance and indexing experience on a minimum of three (3) vertical lift bridges within the previous five years. Submit a complete test procedure, along with the resume of the Professional Engineer conducting the tests, for review and approval by the Engineer prior to the machinery index testing.

Include the following in the test procedure:

- Test method
- List of equipment
- Sample calculations
- Torque zeroing method
- Report format

Ensure that after the index tests have been completed, the Contractor submits a formal report signed and sealed by the Professional Engineer who conducted the tests. Include the following in the report:

- Introduction
- Test procedure and Equipment
- Method of analyzing recorded data
- Presentation of results
- Conclusions
- Calculations
- Graphical representation of torque, strain, and machinery load sharing plotted against lift height

All required machinery indexing documentation, including procedures, resumes and reports, may be combined and submitted with the strain gage balance documentation.

Index the operating machinery to meet the following requirements:

- Final Operating Machinery Index and Load Sharing Condition.
Ensure the two corners, at each end of the bridge, exhibit load sharing with a maximum differential torque split of 55% to 45%. Ensure load sharing between the total operating machinery torques at each end of the machinery room exhibits a maximum differential torque split of 55% to 45%. Index the operating machinery such that the lift span live load bearings are fully seated at all four corners with the lift span fully closed, the lift span and counterweights level, and proper road and sidewalk alignment to the approach spans.

79-8.03M(4) Simulated Wind Load Strain Gage Testing

Conduct additional strain gage load testing in the same manner as the span balance testing after the main motor controls system is installed and the lift span has been properly final balanced and indexed. Ensure a representative from the Electrical drive system manufacturer is on-site for the testing. Ensure the Contractor adds temporary ballast to the lift span to simulate AASHTO wind loading for machinery power requirements. Ensure this testing is a part of the electrical system acceptance testing. Uniformly add weight to the lift span in 20% increments up to 100% of the calculated wind loading. In between each weight addition, operate the lift span to the normal full open lift height to verify proper function of the main mechanical and electrical systems. Record motor amperage readings throughout the testing. Submit a full load testing report to the Engineer, including test results and graphs illustrating motor amperage, torque, strain, span balance plotted against height of lift for each test case.

79-8.03N Functional Acceptance Testing for Mechanical Systems

- Include quantitative measurements (i.e., pressures, clearances, etc.), their method of measurement, and their method of recording, for each test.

- B. Coordinate a Functional Acceptance Test plan such that any failure of the system being tested would not interfere with the scheduled use of the bridge.
- C. Bridge Machinery (where applies):
 - 1. Demonstrate operation of all lubrication systems to be working correctly and show no visual signs of leakage.
 - 2. Demonstrate live load shoe contacts of all shoes and proper alignment of the movable bridge. Contact is defined as full contact along 80 percent of the width of each live load shoe. Contact is considered full if a 0.002-inch feeler gauge cannot be inserted between the live load shoe and the strike plate.
 - 3. Ensure sheave grooves are clean and free of any debris. Sheaves shall be demonstrated to operate smoothly and have no excessive vibrations during operations.
 - 4. Visually inspect wire ropes to ensure they do not have any broken wires, corrosion, rope deformation, loose wires, kinks and flats spots. Properly lubricate wire ropes to wire rope manufacturer spec.
 - 5. Demonstrate span locks operating such that driving and/or pulling the locks causes no change in the contact of the live load shoes, roadway alignment, and walkway alignment. Ensure lock bars are driven without binding and actuator current draw does not exceed 20% FLA during driving or pulling when the lock bar is not engaged with the associated receiver and does not exceed 33% FLA during driving or pulling when the lock bar is in contact with the receiver.
 - 6. Operate the bridge through six continuous cycles at full speed, three cycles for each electric motor. During this, inspect the machinery for proper function. Correct any abnormal conditions to the satisfaction of the Engineer, and retested in its entirety.
- D. Operating Machinery Brakes
 - 1. During the span open and close operations, verify and record the normal automatic set and release operation of the brakes.
 - 2. Demonstrate the brake hand release, each brake, one at a time, and monitor the hand release indication through the PLC.
 - 3. With the span in non-permissive operation mode (locks driven, drives not energized), manually activate the brake set and release and monitor their set/released indication at the control panel.

79-8.030 Bridge Operational Testing Period

Upon successful completion of the Functional Acceptance Testing and the repair of all items that were identified during the acceptance tests, open the bridge for highway and marine traffic, and start a 60-day bridge operational testing period.

Provide all materials and labor to operate and maintain the bridge for the operational testing period. During this period, open the bridge a minimum of 4 times per day. During this period, under observation by the Engineer, test all aspects of the movable bridge and its operation.

Repair or replace any mechanical or electrical component of the bridge that becomes inoperative or defective during the 60-day period at no additional compensation. If correction of inoperative or defective equipment requires installation of components from a different manufacturer, or reconfiguration of components, subject the changes to approval by the Engineer.

Additional acceptance testing of the corrected systems may be required and the 60-day Operational Testing Period may be increased or restarted at the sole discretion of the Engineer.

Perform the tests at no additional compensation.

Train the Owner's personnel in the maintenance and operation of the bridge during the latter 15 days of this 60-day period.

79-8.03P Contractor Supervised Lift Span Operation

Provide a minimum of two personnel to supervise the operation of the bridge after completion of the 60-day bridge operational testing period for a period of 14 calendar days (24 hours a day); and for an additional 14-day period (24 hours a day), provide one personnel. Ensure these personnel are able to operate the bridge, to supervise its operation, and to make any adjustments or corrections that may be required on the mechanical

equipment of the bridge. The personnel will instruct and qualify the employees in the operation of the bridge. There will be no additional cost for any adjustments or corrections required during the two 14-day periods.

79-8.03Q Painting

Cleaning and painting of machinery metalwork surfaces shall conform to the requirements for cleaning and painting as required for the structural metalwork in the structural specification and as modified herein. Indicate cleaning and painting of machinery metalwork on the shop drawings.

Paint manufactured or purchased machinery items in the shop with the manufacturer's premium, high performance, epoxy paint system, recommended for outdoor applications in harsh marine environments, to be submitted to the Engineer for approval. If the manufacturer does not have a recommended high performance paint system, paint the components according to the paint system and requirements specified herein. Ensure that factory painted machinery items are either painted with a top coat color matching as close as possible to the top coat color, as discussed herein, or are hand tool and solvent cleaned and overcoated with the top coat of the specified paint system in the appropriate color as discussed herein. Ensure the Contractor coordinates required paint colors with the machinery component manufacturers. Submit manufacturer's paint system and coat colors submitted to the Engineer for approval.

Ensure the paints are of one manufacturer and conform to the chemical and performance requirements of the manufacturer's published technical data application information, and the referenced specifications.

For shop painted components, blast clean all metalwork to be painted to an SSPC-SP10 near-white blast. Do not permit blast cleaning on site.

Clean machinery metalwork on-site manually using simple hand tools and power tools to SSPC-SP2/3. Clean locations with corrosion with power tools to SSPC-SP15. Accomplish final surface profiling using a handheld rotary wire bristle power tool that has been dynamically tuned to impact, rather than scrape, the metal surface leaving an anchor profile. Ensure all power tools have controlled dust collection attachments. Submit the dust containment procedure and locations where power tool cleaning will be used to the Engineer. Spot prime bare metal cleaned with power tools and apply an intermediate with products previously approved. Roughen the remaining existing paint system by sanding and apply a full top coat to all machinery with a product previously approved by the Engineer.

Ensure all machinery metalwork to be painted receives the specified paint system with the exception of the finished, bearing, and lubricated surfaces.

Ensure the Contractor is not allowed to clean or paint at night. Perform all cleaning and painting only during daylight hours.

Apply coatings in accordance with the manufacturer's recommendations, SSPC-PA 1 Paint application Specification No. 1, and these specifications, whichever is more stringent.

Apply coatings only to surfaces prepared in accordance with the manufacturer's recommendations and these specifications.

Apply paint systems by conventional air spray, airless spray equipment or brush in accordance with the manufacturer's recommendations and these specifications.

Ensure the painted surfaces are free from dry spray, over spray, runs, sags, drips, excessive paint build-up, ridges, waves, laps, streaks, brush marks and variations in color, texture and finish (glossy or dull). Ensure the coverage is complete and each coat is so applied as to produce an even film of uniform thickness, completely coating corners and crevices, and bonded to the underlying surface. When spot repairs are necessary, feather the edges of the surrounding coating, leaving surfaces prior to painting, tapered and free of loose or damaged coating. Exercise care to avoid over spraying or spattering paint on surfaces not to be coated. Repair damage to surfaces not to be coated by the Contractor at the Contractor's expense.

Cover or protect all items not to be painted from cleaning and painting and clean them of overspray. Ensure the coverage and protection measures are submitted to and approved by the Engineer.

The top coat is Federal Safety Orange ANSI Z535.1 for all moving machinery parts (e.g. shafts, couplings, brake wheels, etc.). The top coat color for the stationary machinery parts is Federal Safety Green. Color for machinery support weldments is Federal Standard 17925 (Insignia White).

Before application of paint in the shop, clean surfaces which require painting of all chips, burrs, dirt, rust, mill scale, sand, grease, and other extraneous materials by employing methods such as chipping, grinding, wire brushing, solvents, followed by the required abrasive blast cleaning and residual dust removal by compressed air. Mask finished machined surfaces not to be painted or shielded from abrasive blasting operations. After cleaning, paint surfaces requiring paint with the three-coat paint system. After coupling hubs are installed on all shafts in the shop, paint the remaining exposed portion of shaft, with care to protect any adjacent bearing or seal. Coat bearing or sliding surfaces that are not to be painted with temporary protective materials as previously specified and approved by the Engineer. Nameplates shall be protected to remain clean and free of paint.

Ensure that after the machinery items have been installed in final position on the bridge, all surfaces which require paint, including bolts and portions of shafts remaining exposed after assembly, are cleaned of grease, oil, and loose materials by the use of solvents and compressed air, and all unprimed or damaged shop coated surfaces are repaired with the touch-up primer followed by a full intermediate coat. Ensure that the Contractor takes special care to avoid painting of machinery bearing and sliding surfaces and mask and protect from paint these surfaces and all nameplates, legend plates, and escutcheons mounted on machinery.

After completion of the operating tests and acceptance of the machinery, clean all oil, grease, dirt, and other foreign from the exposed machinery surfaces which require the third coat of paint, including bolts and those shop painted surfaces that were damaged and repaired with field applied primer and intermediate coat. Then give the exposed surfaces a third field coat, the top coat, which will color-code the machinery to identify fixed and moving parts in the machinery room as shown on the shop drawings.

Should the top coat of paint submitted and approved for use on the structural metalwork not be available in the safety colors required for the machinery metalwork, ensure a substitute top coat meeting the color requirements and that is equal in performance to the top coat specified and compatible with the specified intermediate coat is submitted for approval by the Engineer. Ensure the Contractor places a cautionary sign in the machinery room to explain the color code. Submit details of the sign including text, dimensions, mounting locations, and materials to the Engineer for approval.

79-8.03R Lubrication

Ensure the Contractor lubricates components as recommended by individual component manufacturer recommendations and approved lubrication diagram prior to all shop, field and acceptance tests. Ensure the Contractor is responsible for lubricating all machinery components, equipment and assemblies in accordance with manufacturer recommendations and approved lubrication diagram just prior to handing the completed project over to the Owner.

During installation, ensure the Contractor lubricates all rotating and sliding parts of the machinery, and fill all reducers, bearings, and flexible couplings with lubricants indicated on the approved charts. Ensure all lubricants listed on the lubrication charts are approved for use in each proprietary unit by the manufacturer thereof. Ensure the Contractor furnishes an additional supply for future maintenance use to include 25 pounds of each type of grease and 15 gallons of each type of oil.

Ensure the lubricant compound for field dressing the wire ropes is recommended and certified by the manufacturer in writing. Ensure the wire rope lubrication is recommended for long-term (at least 12 months), year-round, outdoor, marine environment use with consideration to ambient temperature ranges between 0 degrees Fahrenheit and 100 degrees Fahrenheit. Ensure the field dressing is compatible with the lubricant used during fabrication and suitable for application by hand brushing, hand pouring, swabbing, or spray can. Ensure the wire rope lubrication includes a rust inhibitor.

Ensure the Contractor furnishes an additional supply of wire rope lubrication sufficient for 5 years of future maintenance as recommended by the manufacturer from the Final Acceptance of the project for all counterweight ropes and operating ropes installed.

After erection is complete, ensure the Contractor makes a thorough inspection to ensure all gears are clean and free of obstruction, that all parts are aligned as closely as practicable without actual operation, and that all bolts are properly tightened. Fill all gear housings to the proper level and supply all rotating and sliding parts with lubricants. Ensure all lubrication requirements listed in the lubrication schedule herein are performed by the Contractor until the final acceptance by the Owner.

79-8.04 PAYMENT

Ensure separate payment will not be made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. All preparation and incidental work necessary to accomplish the installation will be considered incidental to the Lump Sum price.

79-9 BRIDGE OPERATING MACHINERY**79-9.01 GENERAL****79-9.01A Summary**

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Perform work covered by this item by furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Operating Machinery.

Include the installation and alignment of electrical instrumentation and driving motors in this item.

Exclude from this work the supply, shop testing, and field wiring of the electrical instrumentation and driving motors.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS.

Operating Machinery components and equipment include the following:

- Motors (couplings, keys, fasteners, lubrication, mounting and alignment only)
- Primary Enclosed Gear Reducers
- Secondary Enclosed Gear Reducers
- Couplings
- Shafts
- Shaft Bearings (except Sheave Bearings)
- Motor and Machinery Brake Assemblies (except electrical components and field wiring)
- Electrical Instrumentation (fasteners, mounting, and alignment only)
- Machinery bedplates and supporting steel

Incorporate the details and arrangement of the Operating Machinery as shown on the Plans and as specified herein.

79-9.01B Definitions

Not used

79-9.01C Submittals

Provide all submittals in accordance with the requirements indicated in BRIDGE MACHINERY – COMMON PROVISIONS and all requirements herein.

79-9.01D Quality Assurance

Not used

79-9.02 MATERIALS**79-9.02A Enclosed Speed Reducers**

Provide primary and secondary reducers from a single manufacturer.

Provide one primary reducer, located inside the machinery house, coupled to the main motors, auxiliary drive system, and floating shafts, as shown on the contract plans. Ensure the reducer has, at a minimum, two parallel input shafts and two output shafts. Design the primary reducer to accommodate the auxiliary drive machinery input as required by the Design-Builder's machinery design.

Provide two secondary right-angle reducers, one at each end of the longitudinal line shaft, as shown on the contract plans. Ensure the reducers have a single input shaft and double output shafts. Configure the

gearboxes to have opposite rotation directions so that the span uphaul and span downhaul operating ropes pay off the same side of the operating drums on both ends of the lift span.

Provide primary and secondary gearboxes with ratings per AREMA. Base the ANSI/AGMA strength rating on an overload of 250 percent of the full load torque of one span drive motor operating. Base the AGMA durability rating on a single main drive motor operation with a 1.5 service factor. Design the gearboxes to withstand an intermittent load equal to three (3) times the rated full load torque of the driving motor when referred to the input to the reducer, without any component reaching 75 percent of its yield strength.

79-9.02B Enclosed Speed Reducer Testing/Inspection

Test the primary and secondary reducers in the shop prior to assembly with other machinery components.

Secure the reducer to rigidly fix its position during all testing. Provide temporary couplings for the reducer testing that are capable of operation at 200 percent of the reducer shaft rated torque. Secure couplings to shafts using temporary keys with at least an FN1 shrink fit.

After assembly of the reducer, conduct a no-load spin test at 100 percent of rated speed for one hour in each direction. Perform all reducer testing at one location. Block out noise coming from other equipment of the test stand with sound shields if the sound level readings taken at 2 ft from the test equipment surface exceeds 80 dBA with the unit running at 100 percent of rated speed.

Ensure sound level readings, taken at 5 feet from the reducer surface, do not exceed 90 dBA with the unit running at 100 percent of the rated speed. Closely monitor the reducer during the spin test for oil leaks, excessive heating of bearings, excessive vibrations, and any other abnormalities. If noise exceeds the specified limits, leaks are noted, bearing temperature exceeds the Manufacturer's recommendations, atypical vibrations or sounds are evident without instrumentation, or other abnormalities are evident during testing, correct the unit and retest.

Following the no load spin test, run gear boxes at rated speed at 150 percent of full load motor torque for ninety minutes in each direction. Monitor the reducer for oil leaks, excessive heating of bearings, excessive vibration, and any other abnormalities. Record bearing and oil sump temperatures every 15 minutes. Ensure temperature rise of any component does not exceed 100 degrees F over ambient.

At the end of these tests, open the inspection covers and examine all gear teeth for excessive wear and damage. Examine gear teeth for contact patterns. Take pictures of all examined components and provide them to the Engineer for review. Ensure a minimum of 85 percent tooth flank contact is evident. If any relative movement between two fixed mating components is observed that cannot be explained through accepted engineering principles, make adjustments and retest. Replace all out of tolerance parts and make necessary adjustments.

Correct any discrepancies, including behavior which is consistently different from the other reducers, and retest until all criteria are met. Perform retesting at a load required to demonstrate that the defect is corrected. Provide a recommended retest procedure to the Engineer for review and approval. The Engineer reserves the right to require additional no-load, 150%-load, or 200% full-load testing at no additional cost to the Owner until the reducers demonstrate full compliance.

Conduct all required non-destructive testing of the gear box(es) in the manufacturer's shop. Closely inspect the gearboxes for any oil leaks and repair as necessary.

Remove temporary couplings and shaft keys used for the reducer test and install permanent couplings and keys as specified in the Plans.

79-9.02C Motor and Machinery Brakes

Provide electro-hydraulic Eldro thruster type Mill Duty series span drive motor and machinery brakes as noted on the plans. Equip each brake with a low force hand release lever that permits release of the brake without energizing the thruster motor. Mount the lever on the side that provides the easiest access for use. Brakes must be adjustable to independently regulate the time for setting of the brake. Provide one brake for each drive motor (2 total) and one brake on each longitudinal line shaft at the primary parallel shaft speed reducer output shaft (2 total). Locate the motor brakes between each motor and the primary reducer. Furnish brakes with an auto-equalization assembly designed to ensure that the shoes maintain equal alignment, positive and equal braking action and equal lining wear. Do not furnish brakes with a mechanism that automatically compensates

for lining wear. Supply brakes with stainless steel pivot pins, bearings at all main pivots, lube fittings, and any other optional features necessary for corrosion protection. Paint brakes with a finish coat of Federal Safety Orange prior to final assembly.

Use hydraulic oil specifically recommended by the thruster manufacturer with a free operating temperature range between -10°F and +120°F.

Operate the motor and machinery brakes at 460 volts, 3 phase, 60 Hz. Equip each brake with three separate limit switches for interlocking span control supervision and indications. Use two brake limit switches for sequence interlocking on span control operation and for indication of the set and release status of the brakes. Use the other brake limit switch for lock-out of the span control circuitry when any brake is hand released and for indication. Ensure brake limit switches are NEMA 4 rated, oil-tight and furnished and mounted on each brake frame by the manufacturer. See Electrical Item "Bridge Control System" for additional brake and limit switch requirements.

Ensure each motor brake operates on a symmetrical brake wheel with bore and keyway to match the shaft. Ensure each machinery brake operates on a symmetrical brake wheel or disc with bore and keyway to match the shaft. Paint all exposed surfaces as specified elsewhere herein.

Supply brakes with a set delay valve. Initially set the brake delay at 1 second for motor brakes and 2 seconds for machinery brakes. Adjust this delay in the field at the discretion of the Engineer.

Provide each brake with a Type 3R stainless steel brake cover, with slots for drive shafts, and access to brake release lever without removal of cover. Include a hinged lid for inspection purposes. Ensure brake covers do not interfere with other machinery components including brake limit switches and wiring.

79-9.02D Spare Parts

Furnish the following spare parts and store them as directed by the Engineer without additional cost.

1 – Thruster assembly for the motor brakes.

1 – Thruster assembly for the machinery brakes.

1 – Pair of brake shoes for each motor brake.

1 – Pair of brake shoes for each machinery brake.

1 – Set of seals for each type of machinery bearing housing (excluding counterweight sheave bearings)

1 – Set of seals and gaskets for each machinery coupling.

1 – Set of shaft seals for each reducer shaft (primary and secondary)

79-9.03 PAYMENT

Include all costs for the work of this Section, complete in place, in the "Movable Bridge Operating Machinery" Pay Item. Do not make a separate pay item for this work. Consider all preparation and incidental work necessary to accomplish the installation as incidental to the Lump Sum price.

79-10 SHEAVE ASSEMBLIES

79-10.01 GENERAL

79-10.01A Summary

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications,, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Work covered by this item consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Sheave Assemblies.

General requirements for this item is provided in BRIDGE MACHINERY – COMMON PROVISIONS.

Sheave Assemblies components and equipment include, but are not limited to, the following:

- [Counterweight Sheaves](#)
- [Counterweight Sheave Trunnions](#)
- [Counterweight Sheave Bearings](#)
- [Deflector Sheaves](#)
- [Deflector Sheave Bearings](#)
- [Deflector Sheave Shafts](#)
- [Deflector Sheave Supports](#)
- [Idler Sheaves](#)
- [Idler Sheave Bearings](#)
- [Idler Sheave Shafts](#)
- [Idler Sheave Supports](#)
- [Instrumentation Couplings](#)
- [Electrical Instrumentation \(mounting and alignment only\)](#)

[Ensure details and arrangement of the Sheave Assemblies incorporates the details shown on the Plans and specified herein.](#)

79-10.01B Definitions

[Not Used](#)

79-10.01C Submittals

[In addition to the submittals indicated in BRIDGE MACHINERY – COMMON PROVISIONS this item requires the following submittals:](#)

[Submit the following submittals and calculations for review and approval. The calculations shall be sealed and signed by a Professional Engineer licensed in the State of California for review and approval by the Engineer.](#)

- [Counterweight Sheave Assembly Lifting Calculations for Lifting to Tower Tops](#)
- [Counterweight Sheave Thermal Stress Relief Procedure](#)
- [Counterweight Sheave Bearing Installation Procedure](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Counterweight Sheave Assembly](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Counterweight Sheave/Trunnion/Bearing Assemblies on Tower Tops](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Deflector Sheave/Trunnion Shrink Fit Assembly](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Deflector Sheave/Trunnion/Bearing Assemblies](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Idler Sheave/Trunnion Shrink Fit Assembly](#)
- [Detailed Assembly and Alignment Procedure for Installation of the Idler Sheave/Trunnion/Bearing Assemblies](#)

[Submit a letter endorsed by the Counterweight Trunnion Bearing Manufacturer stating the components for this project have been in issue and defect free service for at least 10 years on a movable bridge for review and approval by NYSDOT.](#)

[Submit all required submittals in accordance with AASHTO/AWS D1.5M/D1.5, including Welding Procedure Specification \(WPS\) Qualifications and Welder Qualifications shall be made. Ensure these submittals are subject to the review and approval of the Engineer. Perform no fabrication until these submittals have been approved.](#)

[Submit qualifications of an AWS Certified Welding for review and approval by the Engineer.](#)

79-10.01D Quality Assurance

[Not Used](#)

79-10.02 MATERIALS

[Not Used](#)

79-10.03 CONSTRUCTION**79-10.03A Sheaves, Trunnions/Shfts, and Trunnion/Shft Bearings****79-10.03A(1) Counterweight Sheaves**

Ensure the counterweight sheaves for the main counterweight ropes are weldments made up of structural steel plate and carbon and alloy steel forgings as shown on the Plans. Engineer After completion of welding and before final machining, stress relieve the sheave shall be by heat. Ensure the stress relief heat treatment is in accordance with the requirements of the AWS D1.5 Bridge Welding Code for tension members.

Fabricate the sheave rim from no more than 3 pieces of steel forgings. Weld the sheave rim into a complete ring using complete penetration welds and those welds ground flush on all four sides before being welded to the remainder of the sheave assembly.

Fabricate each web from not more than three pieces of plate. Ensure welds connecting the web plate section are complete penetration welds and are ground flush on both sides.

Ensure the sheave hub is a one piece forging.

Treat all welds as welds on main members in a tension zone and ultrasonically inspect by ultrasonic methods in accordance with AWS D1.5.

79-10.03A(2) Deflector and Idler Sheaves

The deflector and idler sheaves for the operating ropes shall be fabricated from materials as shown on the Plans. Each deflector and idler sheave shall be fabricated from a one piece forging.

79-10.03A(3) Groove Tolerance and Concentricity

Ensure the machining procedure for the counterweight sheaves, counterweight sheave trunnions, deflector sheaves, deflector sheave shafts, idler sheaves and idler sheave shafts is such that the pitch circles of the completed rope grooves are concentric with the finished journal of the trunnion. Ensure the finished diameters at the bottoms of all rope grooves shall not vary by more than plus or minus 0.010 inch, and the radii of the grooves does not vary by more than 0.002 inch. Ensure the Engineer checks all grooves upon completion of machining and prior to the application of the protective anti-rust coating. Make a record of the sheave diameters at the bottom of the grooves and of the groove radii for all grooves of all sheaves and submit to the Engineer.

79-10.03A(4) Counterweight Sheave Trunnion Bearings

Ensure sheave trunnion bearings are rolling element type, self-aligning, anti-friction bearings.

Include in bearing submittals complete calculations verifying bearing capacity, L-10 life, and recommended maintenance, installation, and lubrication procedures.

For each counterweight sheave assembly, ensure one bearing is an expansion (float) type and one a fixed type. Ensure mounting feet on pillow block bases are solid (without holes) to be drilled and reamed in the field after final installation and alignment, with high strength turned bolts. Ensure the bearings incorporate double lip seals to keep out dirt and water and to retain the lubricant. Provide separate fill and purge grease ports at each seal to provide for applying grease between the two seals. Ensure the bearing housings are split pillow block style with removable caps and have removable inspection covers for internal inspection.

Each counterweight sheave trunnion bearing consists of a cast steel base and cap fitted with internally self-aligning spherical roller bearings machined with a tapered bore for hydraulic installation and removal. Machine the cast steel trunnion bearing base and cap with the end caps bolted in place.

Ensure the tolerances for the bearing and sheave trunnion shaft fit are as recommended by the bearing manufacturer. Do not consider or approve a bearing use, unless made by a manufacturer who has had bearings of comparable size and capacity in successful service for a period of at least 10 years.

Ensure the bearing housing end caps include smaller inspection hatches that are sized and located to enable inspection of the rollers and races.

Include instrument drive shaft seals in the bearing housing end cover plate. Provide a minimum of two lip seals with a grease purge cavity between the seals.

79-10.03A(5) Counterweight Sheave Trunnion Shafts

Fabricate the counterweight sheave trunnion shafts from steel forgings as show on the Plans. Fit the ends of each trunnion into the trunnion bearing so the sheave trunnions for each tower will be in exact alignment under full dead load. Turn the journal ends of each trunnion with extreme care to the diameter and taper as specified by the bearing manufacturer, so that the bearing centerlines are at the required center to center distance. Ensure the tapered ends contain passages and grooves for hydraulic removal of the bearings, as specified by the bearing manufacturer. Ensure the bore lengthwise through the center of the trunnion shaft is as shown on the Plans. Ensure the surface finish of the bore is a minimum of 63 microinch.

Cap or plug each end of the bore on the trunnion shaft to prevent grease from filling the bore. Ensure the cap for the bore is type 316 stainless steel plate with the thickness as shown on the plans. Attach the cap to the end face of the trunnion with a minimum of stainless steel (type 316) bolts as shown on the plans that are drilled and tapped into the end of the trunnion and wire-locked together with stainless steel wire.

79-10.03A(6) Deflector and Idler Sheave Shafts

Fabricate the deflector and idler sheave shafts from steel forgings as shown on the Plans. Fit the ends of each shaft into the bearing so the sheave trunnions for each tower will be in exact alignment under full dead load. Turn the journal ends of each shaft with extreme care to the diameter and taper as specified by the bearing manufacturer, so that the bearing centerlines are at the required center to center distance. Ensure if applicable, the tapered ends contain passages and grooves for hydraulic removal of the bearings, as specified by the bearing manufacturer. Ensure the bore lengthwise through the center of the shaft shall is shown on the Plans. Ensure the surface finish of the bore is a minimum of 63 microinch.

79-10.03A(7) Sheave Trunnion/Shaft Assembly

Fit the trunnions/shafts into the sheave hub with a shrink fit. The use of liquid nitrogen for cooling is not permitted. Center the trunnion/shaft in the sheave hub and then drill and dowel in place using high strength "vent type" steel dowels. Calculate the location, quantity and size of dowels as shown on the Plans. Peen the dowel holes after assembly.

79-10.03A(8) Sheave Trunnion/Shaft Supports

Ensure sheave Assembly support steel is as shown on the Plans.

79-10.03B Shop Assembly

Perform all shop alignment verification in the presence of the Engineer.

Measure and record the alignment of all components within each assembly shall be measured and recorded. Should the measurements show any components are aligned outside of the individual components manufacturers' allowable installation tolerances or the tolerances specified herein, ensure the Contractor re-aligns the components until the installation tolerances are met. Ensure re-alignment due to measurements found to be out of tolerance is not the basis for any claim. Submit measurements to the Engineer for review and approval prior to shipment.

79-10.03C Erection of the Sheave and Trunnion Assemblies

During installation of the counterweight sheaves, trunnions, and trunnion bearings, ensure the Contractor provides for the presence and services of engineering representatives of the bearing manufacturer at the erection site during the assembly and installation of the bearings onto the trunnions and during the erection and alignment of the sheave, trunnion, and bearing assemblies, through final alignment with the full dead load applied. Ensure the Contractor pays for and coordinates this requirement with the trunnion bearing manufacturer.

After each sheave/trunnion/bearing assembly is installed and bolted in place, but before the ropes are installed, lubricate the bearings and test to see that the sheave assemblies turn freely. If not, determine the reason, and make the necessary corrections. Ensure a representative of the bearing manufacturer monitors the erection and testing of the counterweight sheave trunnion bearings. The Engineer shall be given at least two weeks notification prior to the testing.

Carefully locate and adjust the counterweight sheave bearings so that the sheaves are accurately aligned. Obtain the alignment of the counterweight sheaves vertically and horizontally such that, when the full dead load of the lift span and counterweights is carried by the sheaves/trunnions, the axes of the sheave trunnions in

each tower will be as near to a straight horizontal line as possible, with a tolerance of 1/16" total offset in any direction and parallel to the centerline of the bridge. Obtain vertical adjustment by use of full size shims. In setting the sheave/trunnion and bearings, make allowance for the anticipated transverse and longitudinal movement of the assemblies under the deformation of all the supporting members due to the total dead load of the span, counterweights, sheaves, ropes, bearings and machinery. Provide tapered shims as necessary to achieve proper bearing alignment.

Carefully locate and adjust the deflector and idler sheave bearings so that the sheaves are accurately aligned. Obtain the alignment of the deflector and idler sheaves vertically and horizontally such that, when the full dead load of the lift span and counterweights is carried by the counterweight sheaves/trunnions, the axes of the sheave shafts are level within 0.010 inches per foot. Obtain vertical adjustment by use of full size shims. In setting the sheave/trunnion and bearings, make allowance for the anticipated transverse and longitudinal movement of the assemblies under the deformation of all the supporting members due to the total dead load of the span, counterweights, sheaves, ropes, bearings and machinery loads. Provide tapered shims as necessary to achieve proper bearing alignment.

79-10.04 PAYMENT

Ensure separate payment will not be made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. Consider all preparation and incidental work necessary to accomplish the installation incidental to the Lump Sum price.

79-11 OPERATING DRUM ASSEMBLIES

79-11.01 GENERAL

79-11.01A Summary

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Work covered by this item consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Operating Drum Assemblies.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS and BRIDGE OPERATING MACHINERY.

Operating Drum Assemblies components and equipment include the following:

- Operating Drums
- Operating Drum Shafts
- Operating Drum Bearings

Ensure details and arrangement of the Operating Drum Assemblies incorporate the details shown on the Plans and as specified herein.

79-11.01B Definitions

Not used

79-11.01C Submittals

In addition to the submittals indicated in BRIDGE MACHINERY – COMMON PROVISIONS, this item requires the following submittals:

- Operating Drums Installation and Alignment Procedure

Submit all required submittals in accordance with AASHTO/AWS D1.5M/D1.5, including Welding Procedure Specification (WPS) Qualifications and Welder Qualifications shall be made. Subject these submittals to the review and approval of the Engineer. Perform no fabrication until these submittals have been approved.

Submit qualifications of an AWS Certified Welding for review and approval by the Engineer.

79-11.01D Quality Assurance

Not used

79-11.02 MATERIALS**79-11.02A Operating Drums, Bearings and Shafts****79-11.02A(1) Operating Drums**

Ensure the operating drums are weldments made up of structural steel plate and carbon and alloy steel forgings as shown on the Plans. After completion of welding and before final machining, stress relieve the sheaves by heat. Ensure the stress relief heat treatment is in accordance with the requirements of the AWS D1.5 Bridge Welding Code for tension members.

Fabricate the operating drum rim from a one piece ring forging. Fabricate each web from a single piece of steel plate. Ensure the operating drum hub is a one-piece forging.

Treat all welds as welds on main members in a tension zone and ultrasonically inspect them by ultrasonic methods in accordance with AWS D1.5.

79-11.02A(2) Groove Tolerance and Concentricity

Ensure the machining procedure for the operating drum sheaves and shafts is such that the pitch circles of the completed rope grooves be concentric with the finished journal of the shaft. Ensure the finished diameters at the bottoms of all rope grooves do not vary by more than plus or minus 0.010 inch, and the radii of the grooves does not vary by more than 0.002 inch. Ensure all grooves are checked by the Quality Control Inspector upon completion of machining and prior to the application of the anti-rust coating. Make a record of the drum diameters at the bottom of the grooves and of the groove radii for all grooves of all drums and submit to the Engineer.

79-11.02A(3) Operating Drum Shafts

Make the operating drum shafts of forged steel as shown on the Plans. Fit the ends of each shaft into the shaft bearings so that the operating drum shafts will be in exact alignment under full dead load. Turn the journal ends of each shaft to the diameter to mate with the operating drum bearings.

79-11.02A(4) Operating Drum Bearings

Ensure operating Drum Bearings are rolling element type, self-aligning, anti-friction bearings.

Ensure bearing submittals include complete calculations verifying bearing capacity, L-10 life, and recommended maintenance, installation, and lubrication procedures.

Ensure for each operating drum assembly one bearing is an expansion (float) type and one a fixed type. Ensure mounting feet on pillow block bases are solid (without holes) to be drilled and reamed in the field after final installation and alignment, with high strength turned bolts. Ensure the bearings incorporate double lip seals to keep out dirt and water and to retain the lubricant. Provide separate fill and purge grease ports at each seal to provide for applying grease between the two seals. Ensure the bearing housings are split pillow block style with removable caps.

Include instrument drive shaft seals in the bearing housing end cover plate. Provide a minimum of two lip seals with a grease purge cavity between the seals.

79-11.03 CONSTRUCTION

After each operating drum assembly is installed, aligned, and bolted in place, but before the operating ropes are installed, lubricate the bearings if required by the bushing material selected and test to see that the drum assemblies turn freely. If not, determine the reason and make the necessary corrections. Give the Engineer at least two weeks notification prior to the testing.

Carefully locate and adjust the operating drum bearings so that the operating machinery is accurately aligned. Obtain the alignment of the operating drums vertically and horizontally such that the axes of the operating drum shafts is level within 0.010" per foot. Maintain the installation tolerance of the per the manufacturer's recommendations during the operating drum alignment. Obtain vertical adjustment by use of full size shims. In setting the operating drums assemblies, make allowance for the anticipated transverse and longitudinal movement of the assemblies under the deformation of all the supporting members due to the total dead load and operational loads. Provide one-piece solid tapered shims as necessary to achieve proper bearing alignment.

79-11.04 PAYMENT

Ensure separate payment is not made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. Consider all preparation and incidental work necessary to accomplish the installation incidental to the Lump Sum price.

79-12 SPAN LOCK MACHINERY**79-12.01 GENERAL****79-12.01A Summary**

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Work covered by this item consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Span Lock Machinery. Work under this item also includes installing and aligning electrical instrumentation and all required shop testing. Pay for field wiring under the electrical work.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS.

Span Lock Machinery includes (but is not limited to) the following:

- Lock Bars
- Lock Bar Guides
- Guide Bushings
- Lock Bar Receivers
- Lock Bar Pin & Keeper
- Hydraulic Power Units, Hydraulic Actuator, all hydraulic hoses and piping
- Electrical Instrumentation/Limit Switches
- Supports, Adapters, Weldments, Brackets

Ensure details and arrangement of the Span Lock Machinery incorporates the details as shown on the Plans and specified herein.

79-12.01B Definitions

Not Used

79-12.01C Submittals

In addition to the submittals indicated in BRIDGE MACHINERY – COMMON PROVISIONS this item requires the following submittals:

Submit proposed shop verification and shop testing procedures and schedules for the Span Lock Hydraulic Power Unit and Cylinders to the Engineer for review and approval.

Submit proposed shop alignment verification and shop testing procedures and schedules for the Span Lock Machinery to the Engineer for review and approval.

Submit proposed procedures and schedules for erection, alignment and field testing of the Span Lock Machinery to the Engineer for review and approval.

Submit a report documenting the results of shop verification and shop testing for the Span Lock Hydraulic Power Unit and Cylinders to the Engineer for review and approval.

Submit a report documenting the results of shop alignment verification and shop testing to the Engineer for review and approval.

Submit a report documenting the results of field alignment measurements and field testing to the Engineer for review and approval.

79-12.01D Quality Assurance

Not Used

79-12.02 MATERIALS**79-12.02A Span Locks****79-12.02A(1) General**

Provide four span lock assemblies and associated parts as shown on the plans.

Provide and install four hydraulic power units (HPUs) as shown on the plans. Install the new HPUs on the pier roof. Mount the HPU to a weldment provided by the contractor to keep the system elevated from the floor.

Provide shims to provide a level mounting surface for the new HPU.

Power and control wiring requirements are presented in the Item "Movable Bridge Electrical and Control System".

79-12.02A(2) Span Lock Assembly Components

The span lock assemblies include the hydraulic power unit, all hydraulic hoses and piping, hydraulic actuator, hydraulic actuator support, lock bars, lock bar guides, guide bushings, guide bushing shims, lock bar receivers, lock bar pins and keepers, and all supports adapters, weldments, and brackets. Ensure all piping, fittings, valves, mounts and hardware are type 316 stainless steel.

79-12.02A(3) Span Lock Hydraulic Power Unit

Provide four (4) 5HP, 8GPM, hydraulic power unit (HPUs) with maximum system pressure set at 850psi for Span Lock Assembly operation that are of simple design and substantial construction. Units must be designed to withstand direct rain and other effects of a wet marine environment. Arrange parts to permit easy erection, adjustment, and replacement of typical maintenance parts. Arrange parts to permit easy access for inspection, lubrication, maintenance and repairs. Provide fasteners adequate to hold parts in place under all conditions of transport and service. Mount all parts, motors, pumps, etc., over a stainless steel drip pan with a minimum volume of actual reservoir volume to contain oil spills when servicing or replacing the unit.

Provide dual hydraulic pumps with single input drive shaft. Pumps must be positive displacement type capable of bi-directional. Provide pumps with the following:

1. Rated for continuous duty at 3000 psi or higher
2. Maximum total displacement of both pumps at 8gpm
3. Ensure the high flow pump is capable of approximately 6gpm at 900psi.
4. Ensure the low flow pump is capable of approximately 2gpm at 2900psi.

Direct couple pumps to an electric motor with maximum drive speed of 1200rpm. Ensure the electric motor is TEFC with seals and rain shield to prevent moisture from entering the motor.

Ensure each power unit has a 3-gallon stainless steel reservoir with sight gauge and water removal breather. Fabricate reservoir from ASTM A276 type 316 - 1/4" plate. Ensure the reservoir is sealed against the ingress of water and capable of containing the fluid even at 90-degree rotation of the entire HPU.

Supply with a return filter and visual clogging indicator. Ensure filter elements have at least a 10-micron rating of Beta 10 = 200 or better.

Ensure hydraulic fluid is mineral oil type AW32.

Provide low level shut down float switch.

Provide all necessary valving required that will provide two stage high/low system performance in both directions of pump rotation. Supply all necessary relief, sequence, and check valves to allow an independent maximum relief setting protection in each direction of pump flow. Ensure valves are screw-in cartridge type arranged in a compact aluminum manifold.

Provide a new auxiliary hydraulic hand pump for manual operation of the span lock bar in the event of hydraulic power unit failure. Ensure the hand pump has its own relief valve and four-way directional control valve such that it can cycle the hydraulic actuator in both directions.

79-12.02A(4) Span Lock Hydraulic Plumbing, Fittings and Mounts

Use mechanical connections that incorporate O-rings as the primary pressure sealing component. Ensure all exposed fittings and tubing are type 316 stainless steel and use SAE straight thread with O-ring. Pipe thread NPT type fitting connections are not allowed.

Provide 3/8" flexible hose of the proper SAE rating, consistent with working pressures of 3000 psi.

Provide type 316 stainless steel quick disconnect connections to the cylinder actuator and auxiliary hydraulic hand pump. Install quick disconnect coupling halves such that the HPU can only be reconnected to the hydraulic actuator in the correct arrangement. Provide hydraulic hoses for auxiliary hydraulic hand pump. Ensure all fittings and hose ends are type 316 stainless steel. Ensure the working pressure of all disconnects, fittings, and hoses are 3000 psi minimum.

Provide type 316 stainless steel shut off ball valves at the fluid output and fluid return to the HPU and at each span lock cylinder connection where the transition from tubing to flex hose is made.

Ensure all mounts and hardware are type 316 stainless steel.

79-12.03 CONSTRUCTION**79-12.03A Erection of Span Lock Assembly**

Provide and install four span lock assemblies as shown on the plans including all piping, hoses, shut off valves and mounts necessary to have a fully operational system. Ensure all piping, fittings, valves, mounts and hardware is type 316 stainless steel.

Erect and assemble each span lock assembly, with all mechanical and support components, and electrical connections on the bridge. Use full size stainless steel shims to adjust to correct position, alignment and elevation. Erect lock assemblies with undersize holes and fasteners, and when adjusted, drilled and ream for turned bolts to be installed.

Make final adjustment of the span lock assemblies only after proper shimming of all live load bearings and at a time when the temperature of the structure is uniform and the wind is calm. Adjust guides and receivers for lock bar clearances so that no binding occurs when span locks are operated.

79-12.03B Span Locks Assembly Testing

1. Submit shop test procedure for complete span lock assembly testing with HPU testing in both directions. Record pressures, motor amperage, and span lock assembly cycle times. Operate each span lock assembly through not less than 15 cycles (driven and retracted) in the shop to ensure function without evident deficiency. Complete all shop testing in the presence of the Engineer.
2. After mounting and adjusting, field test each lock assembly by operating through not less than 3 full extension and retraction cycles while the span is in the closed position.
3. Manually extend and retract each span lock at least three times using the manual HPU hand crank, with all components assembled in place.
4. Operate the span lock assemblies during the electrical sequence testing.

79-12.03C Lubrication

Follow the lubrication provisions of the Bridge Machinery Common Provisions Special Provisions.

79-12.04 PAYMENT

Ensure separate payment will not be made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. Consider all preparation and incidental work necessary to accomplish the installation incidental to the Lump Sum price.

79-13 SPAN AND COUNTERWEIGHT GUIDES**79-13.01 GENERAL****79-13.01A Summary**

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Work covered by this item consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Span and Counterweight Guides.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS.

Span and Counterweight Guides include the following:

- Longitudinal Span Guide Assemblies
- Transverse Span Guide Assemblies
- Span Guide Rails
- Counterweight Guide Assemblies
- Shims
- Fasteners and Hardware

Details and arrangement of the Span and Counterweight Guides incorporates the details as shown on the Plans and specified herein.

79-13.01B Definitions

Not Used

79-13.01C Submittals

In addition to the submittals indicated in BRIDGE MACHINERY – COMMON PROVISIONS, this item requires the following submittals:

Submit proposed shop alignment verification and shop testing procedures and schedules for the Span Guides and Counterweight Guides to the Engineer for review and approval.

Submit proposed procedures and schedules for erection, alignment and field testing of the Span Guides and Counterweight Guides to the Engineer for review and approval.

Submit a report documenting the results of shop alignment verification and shop testing to the Engineer for review and approval.

Submit a report documenting the results of field alignment measurements and field to the Engineer for review and approval.

79-13.01D Quality Assurance

Not Used

79-13.02 MATERIALS

79-13.02A General

Fabricate, test, install, and align longitudinal Span Guide Assemblies, Transverse Span Guide Assemblies and Span Guide Rails as shown on the plans.

Fabricate, test, install, and align counterweight guides as shown on the Plans.

79-13.02B Longitudinal Span Guide Assembly

The longitudinal span guide assembly includes the roller, bushings, shaft, support, shims and hardware as shown on the Plans.

79-13.02C Transverse Span Guide Assembly

The transverse span guide assembly includes the roller, bushings, shaft, support, shims and hardware as shown on the Plans.

79-13.02D Span Guide Rail

Fabricate, align, and install the span guide rail as shown on the Plans.

79-13.02E Counterweight Guides

Fabricate, align, and install the counterweight guides as shown on the Plans.

79-13.03 CONSTRUCTION**79-13.03A Shop Assembly and Testing**

Shop test each span guide assembly by hand rotating each roller at least 10 revolutions in each direction. The assemblies are considered to have passed the shop testing if no unusual noises, movement, vibrations, leaks, binding, interferences, resistances or other deficiencies are noted. Submit results of the shop testing to the Engineer for review and approval prior to shipment.

79-13.03B Erection

Ensure the Contractor field verifies proper alignment between components comprising the Span Guide Machinery and that erection of the lift span, including its deck, prior to final reaming and fastening.

Align all Span Guide Machinery Assemblies with the tower columns with the towers fully loaded by the final dead loads of the span and counterweights. Survey the towers prior to alignment of the span guide assemblies to confirm the towers are properly aligned.

Ensure the Contractor uses custom machined tapered shim plates as needed to achieve these alignments and shall account for the movement and deflection of supporting structural members throughout construction in determining the amount of taper required.

Perform measurements verifying the achievement of these tolerances in the presence of the Engineer and submit to the Engineer for review and approval.

Should the measurements show any components are aligned outside of the allowable installation tolerances or the tolerances specified herein, ensure the Contractor re-aligns the components until the installation tolerances are met. Ensure re-alignment due to measurements found to be out of tolerance is not the basis for any claim against the owner. Submit measurements to the Engineer for review and approval prior to shipment.

Align all Span Guide Assemblies and Counterweight Guide Assemblies to achieve proper alignment with the guide rail at the final balance condition of the lift span.

Drill bolt holes in structural steel for connecting the Span Guide Machinery assemblies from the solid after acceptance of machinery alignment or sub-drilled 1/4-inch undersized for undersized temporary bolts. When the machinery field alignment has been accepted, sub-drill and ream full-size holes for remaining bolts, and the full size bolts or studs installed. After that, replace all temporary erection bolts with full size bolts one at a time.

Drill and ream bolt holes in structural steel, shims, shim plates, and machinery assemblies while assembled to assure accurate alignment of the hole and accurate clearance over the length of the bolt or stud within the specified tolerances. Ensure handheld reamers are not used. Ensure the Contractor uses reaming jigs constructed of structural steel, fixed to the drill, and secured to the work to prevent the reamer from deviating and assuring straight, cylindrical holes. Check all bolt holes with a bolt hole micrometer to verify the required dimensions and tolerances.

79-13.03C Field Testing

Operate the Span Guide Assemblies and Counterweight Guide Assemblies through 6 opening and closing cycles during various weather conditions, temperatures and times of day. During this time, check each component visually and aurally for any unexpected noises, vibrations or interferences. Stop the lift span approximately every 10 to 15 feet of travel and measure the clearances between the guides and the tower steel to an accuracy of 1/32-inch. At the same time, measure the clearance between the counterweight guides and tower steel to the same accuracy. Successfully pass field Testing of the Span Guide Machinery and Counterweight Guide Machinery when the lift span completes the opening and closing cycles with no deficiencies observed. If any deficiencies are noted during testing, ensure the Contractor makes whatever adjustments, corrections or repairs necessary, subject to the approval of the Engineer, and re-start the testing from the first test operation.

79-13.04 PAYMENT

Ensure separate payment will not be made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. Consider all preparation and incidental work necessary to accomplish the installation incidental to the Lump Sum price.

79-14 OPERATING, MAINTENANCE, AND LUBRICATION MANUALS AND TRAINING**79-14.01 GENERAL****79-14.01A Summary**

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Ensure work covered by this item consists of furnishing the Operating, Maintenance, and Lubrication Manual and Training Requirements.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS.

79-14.01B Definitions

Not Used

79-14.01C Submittals**79-14.01C(1) Operating, Maintenance, and Lubrication Manual**

Ensure the Contractor provides an Operating, Maintenance, and Lubrication Manual for all new components. Develop this manual from the recommended practice of the machinery manufacturers. This manual is considered a critical deliverable for the Project. Ensure acceptance of the Project is not given as complete until this manual has been submitted to and approved by the Engineer.

79-14.01C(1)(a) Construction

Ensure binders are hardback vinyl, three-ring, loose-leaf type for binding 8-1/2 x 11 inch sheets. Ensure binders are of manageable size, preferably 10 x 12 inches and not over three inches thick. Along with the binders, ensure that the Contractor provides a CD and a flash drive containing the full and complete manual as required below.

Ensure the binder spine and front cover display labels containing the name of the bridge, the bridge location, the names of the Contractor, Mechanical Subcontractor, and the dates of the work.

Reinforce the binder holes for all contents.

Ensure the paper and ink resist smearing, fading and deterioration from age.

Ensure all lettering is clear and legible.

Ensure all material within the manuals is new. Copies used for prior submittals or used in construction of the project are not acceptable. Only use scanning where actual file conversion is not possible. Only scan images at a resolution of 300 dpi or greater.

Ensure manuals have index tabs for fast and easy reference to equipment and material. Ensure tabs index each system and piece of equipment.

Ensure a table of contents indicates each chapter, section, subsection e.g. specific equipment, and page numbering.

Submit the arrangement of the manual, method of binding, included material, and text to the Engineer for approval prior to submission of the Draft Manuals.

79-14.01C(1)(b) Chapters

Ensure the manual has a format and is divided into chapters as follows:

Designate *Chapter 1* for general information and safety precautions. Include applicable information from AASHTO.

Ensure *Chapter 2* contains the operational description of major systems, subsystems, and major components. Include manufacturer's data brochures (color originals where available), catalog cuts, certified dimensional drawings, and specification sheets.

Ensure *Chapter 3* covers the functional description, including: block diagrams; schematic layout of the entire system; description of subsystem; functional relationship between systems and subsystems.

Ensure Chapter 4 covers scheduled maintenance, where applicable. Provide in this chapter all preventive maintenance procedures to the lowest repairable unit level and any checks, tests and measurements required on a periodic routine basis. Provide preventive maintenance indexes (PMI's) in this section and organize in tabular format to provide quick, easy reference to each preventive maintenance action performed according to the prescribed maintenance interval, as well as applicable preventive maintenance procedures contained within the manual.

Ensure Chapter 5 consists of troubleshooting diagrams (fault isolation trees) to be used by maintenance personnel for isolating fault to the lowest repairable limit level.

Ensure chapter 6 covers all corrective maintenance procedures that are required to repair a particular system, piece of equipment or material back into satisfactory operating condition. Ensure this chapter provides step-by-step procedures for the replacement of defective parts. Make reference according to the applicable test procedures established in Chapter 4. List warnings or precautions to be observed during maintenance.

Ensure Chapter 7 provides step-by-step installation procedures to the lowest repairable limit level for a particular system, piece of equipment, or material.

Ensure Chapter 8 consists of complete parts lists to the lowest repairable limit level for each system, piece of equipment, or material. Ensure parts lists include exploded views of assemblies as required. List the local representative of the parts supplier.

Ensure Chapter 9 includes the duration and contents of all guarantees and warranties.

Ensure Chapter 10 includes half-size prints of approved shop drawings (as-built). Fold the prints to fit into the manual.

Ensure Chapter 11 consists of a spare parts inventory list, which the Owner stores on or off site. Include in the spare parts inventory list the minimum quantity recommended to be stocked by the Owner at any time. Ensure these are items that are frequently replaced and/or have long delivery times when ordered and/or are critical to bridge operations if not stocked by the Owner.

Ensure the Contractor includes recommendations, in writing from the vendor, for the Engineer's approval, of all lowest repairable units for each system, piece of equipment, or material. Define a lowest repairable unit as that equipment which cannot be economically repaired, or which requires skills and equipment beyond those available by the Owner's maintenance personnel. Use the lowest repairable unit concept to prepare all written maintenance, repair, inspection, testing, replacement, and installation procedures for the mechanical maintenance manual covered herein.

Ensure parts lists are in tabular form and include each part name, description, name of manufacturer's order/part number and shop drawing reference. Support parts lists by adequately labeled exploded views or pictorial views where applicable. Include all special tools, jigs, fixtures, test and calibration equipment used in any maintenance, inspection repair or adjustments.

With the exception of shop drawings, ensure all illustrations (block diagrams, schematic diagrams, exploded views, pictorial views printed circuit board layouts, etc.) are single line artwork. Ensure all lettering on illustrations is by lettering guide or equivalent to illustrate call-outs. Ensure all lettering is clear and legible in final form.

Plainly write all written test and descriptive material.

Ensure paragraph numbering is sequential and indicates chapter location. Ensure roman numerals are not used.

Include in the front sleeve of the binder a cover page with descriptive title, project, Contractor, and Engineer.

Visibly highlight safety warnings or cautions within each maintenance procedure. Limit use of such highlights only to critical items and do not use them in an excessive manner which would reduce their effectiveness.

79-14.01C(1)(c) Content Requirements

Ensure vendors' and suppliers' listings include names, addresses, and telephone numbers.

Furnish immediate information in a neatly typewritten index near the front of the manual as to the location in the manual of all emergency data regarding the installation.

Include complete instructions regarding operating, maintaining, lubricating, and adjusting all equipment involved.

Where the contents of the manuals include manufacturer's catalog pages, include the precise items in this installation and delete all manufacturer's data not concerned with this installation, which shall be clearly indicated.

Ensure all material within the manuals is new. Copies used for prior submittals or used in construction of the project are not acceptable. Only use scanning where actual file conversion is not possible. Scan images at a resolution of 300 dpi or greater.

Include all results of testing required by these specifications.

79-14.01C(1)(d) Preliminary and Final Manual Submittals

Following approval of the O&M Manual Outline submittal, make a preliminary manual submittal of three copies to the Engineer and the Owner for review and approval. Submit six copies of the final manual to the Engineer and the Owner. Also, submit an electronic copy of each version.

Furnish submittal of preliminary and final manual editions to the Engineer and the Owner according to the approved official progress schedule.

Present in preliminary manual editions all technical material for the mechanical volume to the greatest extent possible with respect to text, tabular matter, and illustrations. Ensure preliminary manual editions are single column, double-spaced, and typewritten. Ensure illustrations preferably consist of line drawings. (Use sketches or photographs if final line drawings are unavailable at the time of submittal.) Include all applicable shop drawings.

Ensure preliminary manual editions are as technically complete as the final manual edition. Ensure all illustrations are in final form. Include half-size shop drawings.

Ensure final manual editions are technically accurate and complete and represent the "as-built" system, piece of equipment, or material given final acceptance by the Engineer. Ensure all illustrations, text, and tabular material are in final form. Include all shop drawings (as-built).

79-14.01C(1)(e) Electronic Copy Submittals

- Electronic copies of the approved paper copy Operating, Maintenance, and Lubrication Manuals are to be produced in Adobe Acrobat's Portable Document Format (PDF).
- Ensure the PDF is not password protected and/or locked.
- Convert drawings or other graphics to PDF format and make part of the PDF document.
- Only use scanning where actual file conversion is not possible.
- Rotate pages that must be viewed in landscape to the appropriate position for easy reading.
- Scan images at a resolution of 300 dpi or greater.
- Perform optical Character Recognition (OCR) capture on all images.
- Activate OCR with the "original image with hidden text" option.
- Successfully operate word searches of the PDF document to demonstrate OCR compliance.
- Create bookmarks that are three levels deep (i.e., "Chapter," "Section," "Subsection") in the navigation frame, for each entry in the Table of Contents/Index.
- Generate thumbnails for each PDF file.
- Set the opening view for PDF files as follows:
 - o Initial view: Bookmarks and Page.
 - o Magnification: Fit in Window.
 - o Page layout: Single page.
 - o Set the file to open to the cover page of the manual with bookmarks to the left, and the first bookmark linked to the cover page.
 - o Set all PDF documents with the option "Fast Web View" to open the first pages of the document for the viewer while the rest of the document continues to load.

79-14.01C(1)(f) Included Items

Furnish information for all the bridge operating machinery, including the following:

- Primary parallel shaft gear reducer
- Secondary right angle gear reducers
- Motor and machinery brakes
- Couplings
- Bearings and bushings
- Shafts
- Counterweight sheave assemblies and trunnion bearings
- Deflector and Idler sheave assemblies and bearings
- Wire ropes, sockets, and turnbuckles
- Span locks, including hydraulic components, lock bar, guides, and bushings
- Span guides
- Counterweight guides
- Span control equipment drive assembly
- Brackets, Adapters, Weldments and Supports
- Lubrication schedule and diagram (See Details and Workmanship section, Lubrication and Lubrication Schedule subsections for details)
- Span balancing procedure
- Standard operating instructions and emergency operation instructions (Two separate sets of directions.)

79-14.01C(2) Training Submittals

1. Ensure the Contractor submits the training schedule, from review of course materials to field instruction, to the Engineer and the Owner for review and approval.
2. Assume a minimum of 2 x 1 week classroom style training sessions and 2 x 1 week field instruction training sessions.
3. Ensure the Contractor submits to the Engineer and the Owner the outline of topics to be covered and training material for review and approval.

79-14.01D Quality Assurance

Not Used.

79-14.02 MATERIALS

Not Used.

79-14.03 CONSTRUCTION

Not Used.

79-14.04 PAYMENT

Ensure separate payment will not be made for the work of this Section complete in place, but all costs, therefore, are included in the "Movable Bridge Operating Machinery" Pay Item. Consider incidental to the Lump Sum price all preparation and incidental work necessary to accomplish the installation.

79-15 WIRE ROPES AND ACCESSORIES**79-15.01 GENERAL****79-15.01A Summary**

Ensure this work conforms to the relevant provisions of Caltrans Standard Specifications, Supplemental Special Provisions, the Request for Proposal, the Plans and the following:

Work covered by this item consists of furnishing, installing, aligning, lubricating, testing, painting, and placing in satisfactory operating condition the Wire Ropes and Accessories.

General requirements for this item are provided in BRIDGE MACHINERY – COMMON PROVISIONS.

Wire ropes and accessories include the following:

- [Counterweight Ropes](#)
- [Counterweight Rope Connections](#)
- [Operating Ropes](#)
- [Operating Rope Take-ups](#)
- [Operating Rope Connections](#)
- [Operating Rope Tension Monitoring Equipment](#)

[Ensure details and arrangement of the Wire Ropes and Accessories incorporate the details shown on the Plans and as specified herein](#)

[79-15.01B Definitions](#)

[Not Used](#)

[79-15.01C Submittals](#)

[In addition to the submittals indicated in BRIDGE MACHINERY – COMMON PROVISIONS, this item requires the following submittals:](#)

[Submit calculations for lifting wire rope components signed by a Professional Engineer licensed in the State of California for review and approval by the Engineer.](#)

[Submit technical and safety information on the proposed wire rope dressing to the Engineer for review and approval.](#)

[Submit proposed procedure for erection, attachment, initial tensioning, tension measurement and tension adjustment of the wire ropes to the Engineer for review and approval.](#)

[Submit a report, sealed and signed by a Professional Engineer licensed in the State of California, documenting the rope installation, rope tensioning process, and the intermediate tensions of each rope to the Engineer for review and approval.](#)

[Submit proposed procedure for post-construction tension re-measurement and tension re-adjustment of the wire ropes, including a detailed schedule and maintenance and protection of traffic plan, to the Engineer for review and approval.](#)

[Submit a report, sealed and signed by a Professional Engineer licensed in the State of California, documenting the post-construction rope tension re-adjustment process, and the final tensions of each rope to the Engineer for review and approval.](#)

[Submit copies of letters from the wire rope manufacturer endorsing the lubricants and sealants used.](#)

[79-15.01D Quality Assurance](#)

[Not Used](#)

[79-15.02 MATERIALS](#)

[79-15.02A Wire Ropes](#)

[Finish, assemble, and adjust wire rope assemblies in an approved manner and according to the best shop practice as defined by the latest edition of the Wire Rope User's Manual. Place the limits of accuracy that are to be observed in machining the work, and the allowances for all metal fits on the Contractor's working drawings. Ensure fits and finishes of machinery parts are as called for on the contract plans or as specified by AASHTO.](#)

[Ensure the wire ropes are preformed. Ensure the wire ropes have a line painted down the length of the rope to aid in verifying there is no twist in the ropes at installation. Ensure the wire ropes comply with ASTM A1023, A1007 and these contract documents.](#)

[Ensure the wire ropes are manufactured by one manufacturer, whose facilities and experience are approved by the Engineer. Lay ropes in accordance with the best practice. Ensure every effort is made to obtain ropes of uniform physical properties. Fabricate the ropes in the greatest length practical and cut them from ropes manufactured with one setting of one stranding machine, and one setting of one closing machine.](#)

[Prestretch the wire ropes per the following procedure:](#)

- [Tension the rope to 40% of its minimum breaking strength and hold for 5 minutes.](#)

- Reduce the load to 5% of the minimum breaking strength.
- Repeat the load-unload cycle two more times.
- Release the load.

Define the actual diameter of the wire rope as the diameter of the circumscribed circle. Ensure the actual diameter of the rope, measured with the rope unstressed, is not less than its nominal diameter and not more than 1/32" in excess of its nominal diameter.

Ensure all wire ropes are right regular lay.

Ensure the actual length of each wire rope assembly is not less than the specified length when measured at the anticipated tension during operation of the bridge.

Suitably mark or tag all counterweight ropes and operating ropes for identification prior to shipment.

Lubricate all portions of the wire rope during fabrication with a lubricant containing a rust inhibitor.

Do not permit any splicing of the ropes or individual strands.

79-15.02A(1) Counterweight Ropes

Ensure counterweight wire ropes comply with ASTM A1023 and these contract documents. Ensure counterweight rope assemblies are in accordance with the latest revisions of AASHTO Section 6.8.3.3 and Federal Specification RR-S-550.

Ensure all counterweight ropes are independent wire rope core.

Ensure counterweight rope sockets are spelter block sockets made from forged alloy steel, conforming to ASTM A668, Class H. Magnetic particle test and ultrasonically inspect each socket. Select sockets at random for testing, which shall be in accordance with the provisions of this specification, and in accordance with the AASHTO Section 6.8.3.3. Assemble counterweight rope assemblies in accordance with provisions in AASHTO Section 6.8.3.3.

Ensure the actual diameter of the rope, measured with the rope unstressed, is in accordance with AASHTO Section 6.8.3.3. Ensure the maximum length of the rope lay, measured with the rope unstressed, does not exceed the value in AASHTO Section 6.8.3.3.

79-15.02A(2) Operating Ropes

Ensure operating rope assemblies are in accordance with the latest revisions of AASHTO Section 6.8.3.3, and Federal Specification RR-S-550.

Ensure all operating ropes are 6 x 26WS (Warrington Seale) construction with an independent wire rope core.

Magnetic particle test and ultrasonically inspect rope sockets, if used. Select sockets at random for testing, which shall be in accordance with the provisions of this specification, and in accordance with the of AASHTO Section 6.8.3.3. Assemble in accordance with provisions in the AASHTO Manual.

Ensure the actual diameter of the rope, measured with the rope unstressed, is in accordance with AASHTO.

Ensure the maximum length of the rope lay, measured with the rope unstressed, does not exceed the value in of AASHTO Section 6.8.3.3.

79-15.02A(3) Counterweight and Operating Rope Testing

Test ropes in accordance with AASHTO 6.8.3.3 and the following requirements.

The tensile test of the wires shall meet the requirements of Table 1 – Wire Tensile Strength Grades or Levels for Wire Rope Grades, of ASTM A1023. The wire ductility shall be evaluated per Article 3.13.1 of ASTM A1023, which refers to Article 9.2 and Table 3 of ASTM A1007. All wire tests shall be made upon fair samples which may be taken from either end of any coil of wire, and such samples shall be taken from not less than 10 percent of the number of coils.

To demonstrate the strength of the rope and its socket, cut test pieces with a length between the sockets of not less than 25 rope diameters, and preferably not less than 50 rope diameters, and select sockets, at random from the job lot, attached to their ends. Do not use the sockets from these tests in the structure. Ensure the

number of test pieces is not less than two from each manufactured length of rope, but not more than 10 percent of the total number of finished assemblies of rope to be fabricated. Take the test pieces from both ends of the manufactured lengths of rope. Place a suitable mark around the rope near the base of the socket, so that any relative movement of the latter can be readily detected. Movement that exceeds the requirements of AASHTO Section 6.8.3.3.7 is ground for retesting new test assemblies. Test these test pieces to destruction per ASTM A931 Test Methods for Tension Testing of Wire Rope and Strand, in the presence of the Engineer. Ensure wire ropes 2-3/8 inch diameter or less develop the minimum breaking force given in ASTM A1023 for the particular size, construction, grade, and coating (if any). Ensure wire ropes larger than 2-3/8 inch diameter develop the minimum breaking force given in Federal specification RR-W-410F for the particular size, grade, and coating (if any). Ensure wire ropes develop the minimum breaking force given in ASTM A1023 for the particular size, construction, grade, and coating (if any). Ensure wire ropes larger than 2-3/8 inch diameter develop the minimum breaking force given in Federal Specification RR-W-410H for the particular size, grade, and coating (if any).

Where the physical properties of the rope or of its individual wires do not meet those specified, ensure the manufacturer replaces the entire manufactured length with a new length, the physical properties of which conform to those specified.

79-15.02B Wire Rope Connections and Splay Plates

Provide wire rope connections and splay plates for the counterweight wire rope connections on the lift span and counterweight as shown in the Plans.

Provide operating rope take-ups for each operating rope to adjust operating rope tension as shown on the Plans.

79-15.02C Rope Sockets

Ensure all rope sockets meet the performance and geometric requirements of the latest revision of Federal Specification RR-S-550, type A/B zinc-coated sockets, unless noted otherwise. Fabricate sockets from heat treated alloy steel forgings. Forge sockets without welds from solid steel. Ensure spelter sockets, the attachment of all sockets to the wire ropes, and the inspection and non-destructive testing of all sockets conforms to the latest revisions of Federal Specification RR-S-550, and AASHTO Section 6.8.3.3.7. Ensure the requirements for type A (or type B), open (or closed) spelter sockets apply.

Ensure operating ropes have a load washer at the takeups utilizing internal strain gauge transducers manufactured by a manufacture with more than 10 years of experience fabricating load washers. Seal the strain gauges inside small axial holes within the load washer and position at two locations at the rope takeup interfaces. To sense only those strains which are induced by the forces at these two sections, position and orient the strain gauges with great precision, at a neutral plane relative to one specific direction of washer loading.

Electrically connect the four strain gauges (two at each location) to form a full bridge, the signal from each strain gauge being additive so that the bridge output is proportional to the sum of the loads transmitted by the load washer. Ensure the circuit includes temperature compensating and balance resistors terminating in suitable connector socket supplied by the socket manufacturer and is of the size and material suitable for the application.

Galvanize sockets, pins, and cotters in accordance with ASTM A153

Attach all sockets to the ropes in accordance with AASHTO 6.8.3.3.7. Propose resin as a substitute for zinc socketing material for the operating ropes. Ensure the Contractor has experience socketing ropes for a minimum of two movable bridges in the last ten years. Submit the Contractor's relevant work experience, the proposed wire rope socketing material, and the proposed socketing procedure to the Engineer for review and approval.

79-15.02D Operating Rope Tension Monitoring Equipment

Actively monitor operating rope tensions at all times. Integrate the rope tension monitoring system with the bridge control system and the load washers. Ensure the Contractor provides a complete system capable of directly measuring rope tensions and interfacing with the bridge control system. Ensure the system and all

components are rated for use in harsh outdoor environments. Submit the proposed system for review and approval.

Independently monitor and report tension of each operating rope more than once a second in real time to an accuracy of 5%. Display tension measurements in real time on a display visible from the operator's station and on the bridge control console HMI. Ensure rope tensions exceeding 20% of the mean breaking strength (MBS) of the rope display a warning. Ensure rope tensions exceeding 30% MBS of the rope display a warning and sound an audible alarm and rope tensions exceeding 40% MBS of the rope display a warning, sound an alarm, and stop the operation of the span.

Calculate a 5 second rolling average of the average tension for all uphaul ropes, and a 5 second rolling average of the average tension for all downhaul ropes. If an uphaul rope deviates from the 5 second rolling average for the uphaul ropes by more than 500% for more than 5 seconds, automatically bring the span to a controlled stop. Similarly, if a downhaul rope deviates from the 5 second rolling average for the downhaul ropes by more than 500% for more than 5 seconds, automatically bring the span to a stop. Ensure a warning tells the operator to check for failed operating ropes before continuing. Ensure the operator is given the ability to bypass this check for 1 hour.

79-15.03 CONSTRUCTION

79-15.03A Operating Ropes

79-15.03A(1) Installation of Operating Rope Assemblies

Do not twist the operating ropes during installation. Carefully remove the operating ropes from reels or coils by revolving them and erect them as to avoid any kinks or bends. Do not pull the ropes through dirt or water. Ensure the stripe painted on each rope in the shop is straight and facing outwards after the rope is installed. Ensure the painted stripe indicates a rotation of the rope less than 7½ degrees per 50 feet of rope length. Ensure the Contractor shows the erection procedure for the operating ropes on the shop drawings and submits them to the Engineer for approval.

After the lift span is in operating condition, ensure the Contractor properly cleans all ropes of all foreign material and furnishes and apply, in an approved manner, and when weather conditions are suitably dry and warm, at least one coat of the lubricant compatible with that applied during the rope fabrication and recommended by the wire rope manufacturer in writing. Ensure the applied rope coating fully coats the ropes with multiple applications potentially being required. Ensure the Contractor submits copies of letters from the wire rope manufacturer endorsing the lubricants used.

79-15.03A(2) Operating Rope Tensioning – Recommended Method

After each rope has been placed on the drum, with the painted stripe straight and facing outward, and it has been connected to the take-up assemblies at the rope terminations, ensure the Contractor initially adjusts the ropes to proper tension as determined by Contractor and their Engineer. Determine proper operating rope tension by the Contractor and their Engineer which results in smooth bridge operation. Submit all tension measurements to the Engineer in a report containing tabulated or graphical representations of the distribution of the rope tensions.

79-15.03B Counterweight Ropes

79-15.03B(1) Installation of Counterweight Rope Assemblies

Do not adjust the rope length after shipment from the manufacturer.

Carefully remove the counterweight ropes from reels or coils by revolving them and handle and erect them as to avoid any kinks or bends. Do not pull the ropes through dirt or water. Ensure the stripe painted on each rope in the shop is straight and facing outwards after the rope is installed. Ensure the painted stripe indicates a rotation of the rope less than 7-1/2° per 50 feet of rope length. Ensure the Contractor submits to the Engineer for approval, and shows the erection procedure for the counterweight ropes on the shop drawings, including the transfer of load onto the ropes.

Clean the lift span connection points and rope splay plates and remove all sharp edges prior to the installation of the new counterweight ropes. Lubricate rope contact areas. Paint all other exposed surfaces.

Submit a detailed procedure for transferring the complete counterweight load to the counterweight ropes for review and approval.

Once the counterweight ropes are installed and carrying the full weight of the counterweight, ensure the Contractor adjusts lift span live load bearing shims to ensure that all four bearings are fully seated when the lift span is in the closed position and the lift span and counterweights remain level. Ensure the Contractor verifies that proper roadway and walkway height alignment to the approach is maintained with any lift span live load bearing shim adjustments. Do not permit vehicles and pedestrians to cross the lift span until the Contractor has made adjustments to achieve proper live load bearing seating conditions and the span locks are fully installed and engaged.

Lubrication of the ropes after erection: After the lift span is in operating condition, ensure the Contractor properly cleans all ropes of all foreign material and furnishes and applies hot, in an approved manner, and when weather conditions are suitably dry and warm, one coat of the lubricant compatible with that applied during rope fabrication and recommended by the wire rope manufacturer in writing.

79-15.03B(2) Counterweight Rope Tensioning – Recommended Method

After placing each rope on the sheave, with the painted stripe straight and facing outward and connected to the counterweight and lift span, ensure the Contractor initially adjusts the ropes to proper tension. After the Contractor has conducted the preliminary rope tension adjustments, span balance testing and after the span has been operated through no less than 10 operating cycles, ensure the Contractor re-measures rope tensions and make tension adjustments. Use the following method to adjust individual rope tension by counting vibrations. The Contractor may propose alternative methods to the Engineer for approval.

1. Place the entire weight of the counterweights onto their counterweight ropes.
2. Initially tension the ropes until the average frequency for each individual rope is within 5% of the average frequency for all of the ropes at one corner of the span. Induce vibrations in each wire rope, one at a time. Using a stopwatch, record the time for twenty vibrations (first order “free vibrations”). Conduct three separate tests for each rope and calculate the average number of vibrations per second. Ensure variation between tests is less than 0.1 seconds. Use any approved method to establish the vibrations in the ropes; the frequency of the vibrations does not depend upon the method used. Ensure useable vibrations are noticeable to the touch and are first-order.
3. After the span balancing and after at least 10 operation cycles, re-measure the wire rope tensions and adjust tensions. After tension adjustments are made, operate the span at least three times followed by retesting each rope. Repeat this as required until the average frequency for each individual rope is within 5% of the average frequency for all of the ropes at one corner of the span. Ensure each rope’s painted stripe remains straight and facing outward after the rope adjustments are completed.
4. Submit all tension measurements, including any tension adjustments performed, to the Engineer in a report containing graphs showing the distribution of the rope tensions.
5. Perform this procedure at both ends of the span.

79-15.03C Rope Tension Re-Measurement and Re-Adjustment

After the bridge has been in regular service for at least six months, but prior to the end of the Contractor’s Warranty period, ensure the Contractor re-measures the rope tensions and re-adjusts the rope tensions using the same approved methods used during construction or by an alternate method approved by the Engineer. Perform rope tension re-adjustment iteratively until all rope tensions are approved by the Engineer.

For new operating rope installation, after adjustment of tensions, ensure a portion of each take-up assembly remains for future adjustment. Therefore, rope length may need to be adjusted at the rope end connected to the operating drum, and not at the tower connections. Ensure the Contractor coordinates the work schedule, marine traffic interruptions and vehicular traffic interruptions with the Owner and submits a maintenance and protection of traffic plan to the Engineer for review and approval.

79-15.04 PAYMENT

Payment will be made for the work of this Section complete in place under the “Movable Bridge Counterweight Ropes and Operating Ropes” Pay Item. All preparation and incidental work necessary to accomplish the installation will be considered incidental to the Lump Sum price.

79-16 MOVABLE BRIDGE ELECTRICAL AND CONTROL SYSTEM**79-16.01 GENERAL****79-16.01A Summary**

Provide all labor, materials and equipment for the complete movable bridge electrical and control system, including all incidental work.

79-16.01B Definitions

Reserved

79-16.01C Submittals

Obtain approval for all submittals prior to the purchase, delivery to the site, or commitment to this project of the respective equipment or materials. Provide neat and easily readable submittals, clearly show dimensions and pertinent ratings, and explicitly identify the intended use of each component on this project.

Each set of product submittal information must cover only one distinct product or similarly grouped products.

Submit corresponding descriptive data and system shop drawings all together.

When submitting revised submittal packages where pages from the previous submittal were marked approved, include the previously approved pages with the original stamp of approval.

Do not use or install equipment or perform any work on this project without approved equipment, materials, and associated shop drawings.

Provide the following submittals in portable data format (PDF) for the required work and products.

79-16.01C(1) Product Information

Product information must include brochures, catalog cuts, manufacturer's specification sheets, manufacturer's recommended installation, maintenance, and troubleshooting, and other product literature for all equipment, components, and hardware proposed for installation. Specifically, submit product information for the following components:

1. Movable bridge electrical system equipment including power distribution equipment, general purpose conductors, conduits and raceways, pull and junction boxes, and accessories.
2. Movable bridge control system equipment including programmable logic controller (PLC) system components and related items, relays, indicator lights and switches, limit switches, enclosures, communication and special cables, and accessories.
3. Movable bridge main drive system equipment, including main drives, main drive motors, and accessories.
4. Navigation lighting, maintenance lighting, and receptacles.
5. SCADA (Supervisory Control and Data Acquisition) equipment and graphical user interface (GUI) and HMI hardware, software, and design information.
6. CCTV system equipment including CCTV management system hardware and software, cameras, and related items.
7. Public address system equipment.
8. Boat detection sensors and related equipment.
9. Cable chain system components including cable data and material and finish information.

Where a catalog cut sheet is submitted with a table, listing or group of similar items with different catalog numbers and/or options, clearly mark the specific item(s) proposed.

Where manufacturer documentation contains multiple components, include only the pages that contain relevant information for the products intended for use.

79-16.01C(2) Shop Drawings**79-16.01C(2)(a) Installation and Layout Drawings**

Submit installation and layout drawings to show the proposed locations and dimensions of equipment and clearances to floors, walls, ceilings, structural members, mechanical components, and other nearby objects and equipment. Clearly illustrate the physical relationship between new and existing components, critical dimensions, and modifications to be made to existing conditions and features. Clearly show the proposed method of attachment, mounting details, specific hardware, and holes to be drilled or cut in masonry. Detail

custom or commercial mounting hardware and/or mounting brackets. Describe all installation procedures including alignment, testing, calibration, waterproofing, and as recommended by the manufacturer of the equipment being installed. Drawings need not necessarily be to scale but show items in their proper relative positions and provide dimensions. Field verify all pertinent information regarding existing features and dimensions prior to preparation of the drawings. Indicate dimensions obtained by field measurement as such on the drawings.

79-16.01C(2)(b) Cabinet Layout Drawings

Submit equipment enclosure, panel, and terminal cabinet layout drawings. On terminal cabinet layout drawings, clearly indicate all wires, including spares, to be terminated and coordinate wire numbering with wiring diagrams and other shop drawings.

79-16.01C(2)(c) Conduit and Raceway Layout Diagrams

Submit conduit and raceway layout diagrams to show each raceway utilized, with all wire numbers installed therein. Tabulate all raceways, boxes, cabinets, and equipment enclosures, device served and function of each conductor and spare conductors with assigned wire numbers and present in tabular or spreadsheet format. Clearly indicate all wire numbers passing through or terminating in each raceway, box, cabinet, and equipment enclosure. Use different symbols to clearly distinguish between underground, concrete encased, in-wall, and exposed conduits, as well as cable trays, wire trough, flexible conduits, flexible cables, wireways, junction boxes, terminal cabinets, equipment, and enclosures. Fully coordinate drawings with all wiring diagrams, tabulations, and other shop drawings.

79-16.01C(2)(d) Schematic Wiring Diagrams

Submit full schematic wiring diagrams depicting all required power and control wiring, including, if applicable, connections to existing wiring and equipment.

On schematic wiring diagrams, show all circuit phase, neutral, and grounding conductors. Identify all conductors on the diagrams by wire numbers that match the same conductors or connections shown on other diagrams and shop drawings. Clearly indicate the size and type of all conductors on wiring diagrams. Wiring diagrams are not intended to be to scale, but must show all equipment, terminal cabinets, junction/pull boxes, and splices.

79-16.01C(2)(e) Miscellaneous Shop Drawings

Submit bridge control system graphical user interface (GUI) and HMI graphics. Include a menu structure tree showing screen navigation, example screens (color printouts), and color conventions.

Submit bridge control systems architecture with rack layouts, input/output/specialty card type and placement, and communications connections.

Submit CCTV and public address system architecture with communication connections.

Submit CCTV camera field of view plan and description for each camera.

Submit complete bill of materials for all components including spare parts. Present bill of materials in tabular format. Clearly identify all components by designation and/or description, along with manufacturer's name and complete model or catalog number.

Submit mounting and support details for all electrical equipment. Specifically, provide shop drawing(s) for typical conduit support(s), junction and pull box(es) support(s), mounting of all wall-mounted style electrical enclosure(s), and light fixture and miscellaneous fixture mounting.

Submit cable chain system attachment details.

79-16.01C(3) Miscellaneous Submittals

Submit the PLC program in ladder logic format (see section 79-16.03N).

Submit certified drawings and prints with certified ratings and dimensions. Certified drawings must clearly depict all critical dimensions, as well as all electrical and mechanical ratings. Manufacturer's standard catalog drawings are not acceptable in place of certified drawings.

Submit assembly drawings for fabricated items and assemblies.

Submit testing procedures as described in section 79-16.03P.

Submit a power system study report including arc flash analysis. Report must include calculations and relevant code references to determine the degree of arc flash hazard labels for all electrical enclosures and terminal cabinets per the arc flash safety requirements of NFPA 70 and NFPA 70E.

Submit the lightning protection system materials and layout.

Prepare and submit calculations for uninterruptible power supplies as described in section 79-16.02G(4).

Submit calculations with corresponding descriptive data and system shop drawings.

Prepare and submit approved as-built drawings as described:

1. Utilize a set of approved shop drawings (incorporate all review comments if approved as noted) and mark, in red, all changes made in the field.
2. Maintain these construction shop drawings as working drawings for the duration of construction. Required working drawings include all shop drawings listed in section 79-16.01C(2). Make working drawings available, on request, for review of construction issues.
3. Maintain a full set of working drawings on the job site at all times.
4. Upon completion and final acceptance, prepare and submit the final set of as-built drawings showing all modifications, field changes, revisions, and notes. Draft as-built drawings from the marked up working drawings in CADD format. Do not use existing drawings with mark ups in the as-built drawing set.

Upon completion and final acceptance, develop and furnish bridge operation and maintenance manuals. Provide both hardcopy and electronic portable document format (PDF) format versions. Hardcopy binder(s) must be hardback vinyl three ring loose-leaf type for binding of 8½ by 11-inch sheets. The manual(s) must contain the following chapters:

1. Table of Contents.
2. Introduction, including a general description of the bridge and its facilities.
3. A detailed description of the bridge sequence of operation and bypass switch functions. Include step-by-step raising and lowering procedures to operate the lift span. Include a detailed alarm listing and corresponding operator level troubleshooting steps.
4. Maintenance troubleshooting procedures for PLC and variable frequency drive fault and errors. Include a list of all drive fault and error codes with a detailed description and corrective action. Include GUI display information including screen menu structures and actual screen captures (in color) to illustrate the features and functions available from the GUI to identify problems.
5. Complete drive parameter listings for the installed Variable Frequency Drive (VFD) and basic troubleshooting instructions including common drive HMI error messages.
6. Complete, as-built, PLC program listing including descriptive address comments and symbols, line comments, and cross reference listing.
7. SCADA information including hardware information, installed software with version and license information, network configuration, address information, and other relevant features and information.
8. Catalog cut sheets and user manuals (including manufacturer recommended maintenance) for each type of new equipment including PLC hardware, SCADA system hardware, CCTV and network equipment, PA system equipment, boat detection system equipment, power distribution equipment, raceways, cables, conductors, boxes and cabinets, bridge control components, lighting fixtures, navigation lighting, variable frequency drive hardware, and accessories.
9. Network information for control system related items including architecture drawings showing all assigned network addresses for control system related devices, switch settings, and parameter listings for all programmable network switches and similar devices.
10. Half-size (11x17) prints of as-built contract and shop drawings.
11. Complete spare parts list.

Submit Contractor experience and qualification logs to comply with section 79-16.01H.

79-16.01D Quality Assurance

Reserved

79-16.01E Warranties

Comply with section 5-1.47. Assign manufacturer's warranties on products furnished and installed for the project to the Owner in writing.

79-16.01F Execution

Employ electricians and helpers who are trained and experienced in the installation and maintenance of industrial electrical power and control systems to perform electrical work, and specialty technicians, mechanical and structural workers who are trained and experienced in the type of work they are performing. Ensure all electrical work is supervised by supervisory personnel.

Complete all work in a professional and safe manner in accordance with *NECA 1*. Verify all relevant dimensions prior to performing any work and comply with *NEC* required clearances (i.e., "Working Space", "Dedicated Equipment Space", etc.). Immediately inform the Engineer of any conflict between equipment locations shown on the plans and *NEC* required clearances. Ensure in the case of any such conflict, the equipment in question is relocated or similar remedial action taken.

Physically install all products in a secure manner as indicated and as required to provide a reliable installation. Inspect and test all installed products for correct installation, performance, and workmanship. Torque all terminals and other current carrying connections per the manufacturer's recommendations using calibrated tools. Provide nameplates and necessary warning labels for all equipment, cabinets, and boxes.

79-16.01G Electric Motor Service Vendor

Engage a properly qualified electric motor service vendor (EMSV) to procure, provide, shop-assemble, and site-test the main drive motor(s). To be considered properly qualified, the EMSV must be primarily and regularly engaged in the procurement, service, installation, and maintenance of inverter duty rated squirrel cage motors, and have been in the business of inverter duty rated squirrel cage motors for at least 5 continuous years as of the bid date.

The EMSV must perform all this work and assist the Contractor in the installation of the main drive motors.

Provide start-up services. The EMSV must provide a factory-trained field service Engineer/Technician to check out all equipment and system installation on-site, including wiring interconnections to the main drive motor(s).

79-16.01H Control Systems Vendor

Engage a systems integrator as the control system vendor (CSV) primarily and regularly engaged in the integration, installation, and maintenance of industrial control systems, with demonstrable experience in the integration, installation, and startup of movable bridge control systems. The CSV must have successfully completed five (5) movable bridge control systems in the past seven (7) years, three (3) of which must have incorporated a PLC system. In the five successfully completed control systems of movable bridges, at least one must involve a tower drive vertical lift span type movable bridge. The CSV must have the following experience:

1. Providing relay-based, hardwired control systems.
2. Programming vector-controlled alternating current (AC) drive systems utilizing motors up to 100 horsepower.
3. Programming and integrating a GUI or HMI into a PLC and bridge drive system.
4. Networking and programming a web-based SCADA system and integrating the bridge PLC and controls into the SCADA system for remote monitoring and control.

Concurrent with submission of the bid, identify the intended Control System Vendor, and submit a previous experience log to verify that the CSV meets the requirements. Include previous project references, including names of bridge owners and contact persons with phone numbers in the log. Control System Vendors unable to demonstrate compliance with the above requirements will not be accepted, which may be deemed cause for disqualification and rejection of the bid.

Engage a CSV to integrate all components necessary for a fully functioning, safe, and reliable bridge control system. The CSV must provide all equipment, accessories, and other materials required to produce the desired performance and functionality of the bridge control system, even if they are not specifically identified or implied. Engage a CSV to perform the following work:

1. Acquire and shop-assemble the bridge control system components.
2. Furnish equipment as part of the integrated control system including the PLC system, SCADA system, CCTV system, network equipment, bridge control system, all bridge limit switches, and all miscellaneous bridge control components.
3. Develop the PLC program; develop and configure the GUI and HMI program and graphics.

4. Configure drive parameter settings, including matching the appropriate motor parameters to the main drive motor(s) and tuning the variable frequency drive(s) to the main drive motor(s) to optimize the running and performance characteristics of the main drive motor(s).
5. Perform all interfacing and connections of the bridge control system.
6. Assist the Contractor in testing and in the development and execution of the as-built drawings and personnel training.
7. Perform the shop test to comply with section 79-16.03P(3).
8. Provide start-up services by a factory-trained field service engineer/technician to check out all equipment and system installation on-site, including wiring interconnections to the PLC system and other equipment. Provide start-up services prior to and during the initial operation of the bridge. The field service engineer/technician will remain or return on-site during system start-up and must return for at least one additional site visit immediately prior to final acceptance of the control system to make final adjustments to the control system.

79-16.01I Delivery, Storage, and Handling

Properly store and protect all materials and products until installation, including during shipment and storage. Securely mount and store all large, bulky, and/or heavy items on skids or pallets of ample size and strength. Box all small parts in sturdy wood or heavy corrugated paperboard boxes. Provide weatherproof covers to protect materials from weather, when stored outdoors.

79-16.02 MATERIALS

Provide UL listed or recognized products for all materials.

79-16.02A Wire and Cable

79-16.02A(1) Conductors for General Purpose Use

Provide type XHHW-2, rated 600 volts, uncoated soft copper conductors that comply with ASTM B 3 and ICEA S-95-658 (NEMA WC 70). Provide stranded conductors that comply with ASTM B 8. Use cross-linked polyethylene insulation compound. Use conductors rated 90 degrees Celsius in wet and dry locations, heat, and weather resistant, and suitable for use in raceways.

79-16.02A(2) Conductors for Installation within Control Cabinets

Provide ASTM B 8, Class B stranded copper type THWN-2 or MTW rated 600 volts, 90 degrees Celsius, minimum 16 American wire gauge for control conductors.

79-16.02A(3) Bonding Jumpers and Equipment Grounding Conductors

Conductors must comply with section 86-1.02F(2)(c)(ii). Insulated conductors must comply with section 79-16.02A(1).

79-16.02A(4) Weatherproof Cable

Use type SEOOW or STOOW cable, rated 600 volts, 105 degrees Celsius, outdoor use with oil, water, and sunlight resistant jacket.

79-16.02A(5) Cable Connector

Use stainless steel cable connector(s) with stainless steel mesh strain relief grip of size and type for compatibility with cable. Provide cable connector(s) with embedded O-ring or neoprene gasket for liquid-tight seal.

79-16.02A(6) Variable Frequency Drive Cable

Use variable frequency drive (VFD) cable for motor feeder cables from all variably frequency drives to their corresponding motors. Each VFD cable must consist of three ungrounded copper conductors (class D stranding with cross-linked polyethylene (XLPE) XHHW-2 rated insulation) and three symmetrically placed bare copper grounding conductors, with two spiral copper tape shields with 100 percent coverage. Outer jacket shall be sunlight and oil-resistant PVC. Overall VFD cable must be rated for 1000 volts and 90 degrees Celsius in wet and dry locations.

79-16.02A(7) Ethernet Cable

Use Ethernet cable rated ANSI/TIA-568.2-D Category 6A, IEEE 802.3bt, ANSI/NEMA WC-CC, and suitable for installation in raceways, with high density polyethylene insulation, and sunlight and oil resistant PVC outer jacket, rated 300 volts. Use Ethernet cable with a 100% coverage shield, compatible with RJ45 connectors.

Employ personnel with necessary training and use manufacturer recommended tools to terminate the cable and perform testing.

79-16.02A(8) Fiber Optic Cable

Use loose tube, dry (gel-free), all-dielectric (non-conductive), single mode fiber optic cable, fully water blocked, suitable for outdoor raceway applications. Use fiber optic cable that complies with following additional requirements:

1. Number of fiber strands as indicated on the Plans.
2. Polyethylene outer jacket with ultraviolet radiation, fungus, and abrasion protection.
3. G.652.D, OS2, 1310 / 1383 / 1550 nm operating wavelength.
4. 0.35 dB/km / 0.35 dB/km / 0.25 dB/km maximum attenuation.
5. Ready for Gigabit and 10 Gigabit Ethernet transmission speeds.
6. Operating temperature range of -40 to 70 degrees Celsius.
7. Minimum bending radius of 15 times its outside diameter during installation and 10 times its outer diameter during operation without changing the characteristics of the fiber optic cables.
8. Meets the current requirements of Telcordia GR-20 and ICEA S-87-640.
9. Color coding per TIA/EIA 598 B and design and test criteria per ANSI/ICEA/IEC/TIA.
10. Manufacturer of fiber optic cable and related components must utilize the most advanced commercial materials and manufacturing process and must be ISO 9001 certified.

79-16.02A(8)(a) Fiber Optic Hardware

Use fiber optic hardware to splice, terminate, and/or pigtail fiber optic cable in all terminal cabinets and enclosures.

Provide hardware in all other enclosures to allow for easy access to connect equipment to the fiber optic hardware via fiber optic patch cords.

Fiber optic hardware will include housings, modules, panels, cassettes, pigtails, and/or splice trays. Use hardware and connectors appropriate for each specific application meeting the requirements of ANSI/TIA/EIA-568. Coordinate characteristics of hardware with fiber optic cable and connectors. Use heat-shrink fusion splices.

79-16.02A(8)(b) Fiber Optic Patch Cords

Provide bend-insensitive fiber optic patch cords meeting the requirements of ITU and TIA, same fiber type as fiber optic cable. Provide connectors for fiber optic patch cords as required for compatibility with fiber optic hardware and equipment.

79-16.02A(9) Encoder and Resolver Cable

Provide encoder cable that is compatible with the factory mounted incremental encoder provided with the main drive motor(s) and resolver cable that is compatible with the resolver and PLC interface, with overall 100% coverage shield. Cables must comply with the main drive motor encoder manufacturer and resolver manufacturer requirements and specifications.

79-16.02B Conduit, Raceways, and Accessories

Conduit must comply with section 86-1.02B and as follows:

The use of Type 5 (intermediate steel) conduit is not permitted.

Ensure all conduit installers are certified by the conduit manufacturer.

79-16.02B(1) Rigid Galvanized Steel Conduit

Use Type 1 (hot-dip galvanized rigid steel) conduit and fittings for installation in damp and dry locations. The following additional requirements shall apply:

1. Manufactured from steel tubing having a wall thickness equivalent to Schedule 40 pipe with the entire length of the conduit hot-dip galvanized inside and out, threads hot-dip galvanized after cutting.
2. Unless otherwise noted, use hot-dip galvanized steel channel, U-bolts and conduit clamps for conduit mounting.
3. Provide components (couplings, elbows, fittings, etc.) of same material and manufacturer as the rigid galvanized steel conduit.

79-16.02B(2) PVC Coated Rigid Galvanized Steel Conduit

Unless otherwise noted, use Type 2 (polyvinyl-chloride (PVC) coated rigid galvanized steel) conduit for installation in wet locations. Comply with the following additional requirements:

1. Manufactured from steel tubing having a wall thickness equivalent to Schedule 40 pipe with the entire length of the conduit hot-dipped galvanized inside and out.
2. Hot-dip galvanized steel surface coated with a factory-applied PVC coating, at least 40 mil thick, permanently fused to the hot-dip galvanized surface. Ensure the adhesion of the PVC coating to the conduit is greater than the strength of the coating itself.
3. Coat couplings, elbows, fittings, and conduit bodies used with the PVC coated steel conduit with the same coating as the conduit. Unless otherwise noted, coat U-bolts and conduit clamps used for conduit mounting with the same coating as the conduit.
4. Provide components (couplings, elbows, fittings, clamps, etc.) manufactured by the same manufacturer as the PVC coated rigid galvanized steel conduit.

79-16.02B(3) PVC Conduit

Unless otherwise noted, use Type 3 (PVC) conduit for installation underground and embedded in concrete. Comply with the following additional requirements:

1. Schedule 80, ANSI/UL 651, NEMA TC-2, sunlight resistant, rated for 90 degree Celsius cable.

79-16.02B(4) Conduit Bodies

Use conduit bodies that comply with the following requirements:

1. NRTL listed, hot-dip galvanized cast iron alloy with threaded hubs and integral bushings, and with galvanized steel or iron alloy covers for use with RGS conduit. Use screw-in type covers. Do not use clip-in or other wedge type covers. Use stainless steel cover screws.
2. Use PVC coated conduit bodies and associated covers and screws with PVC coated rigid steel conduit. Use PVC coating of the same manufacturer as the PVC coated steel conduit.

79-16.02B(5) Liquid-Tight Flexible Metallic Conduit

1. NRTL listed liquid-tight flexible metallic conduit (LFMC), formed from a spiral wound strip of heavy gauge, corrosion-resistant, hot-dipped galvanized steel.
 2. Use LFMC with rugged, flexible PVC, oil, mild acid and ultraviolet (UV) sunlight resistant outer jacket extruded over the steel core.
 3. Use LFMC fittings of the same make and material as the rigid galvanized steel conduit for dry and damp locations and the PVC coated rigid steel conduit for wet locations and with sealing gasket or sleeve.
- Provide heavy-duty stainless steel mesh support grips to support LFMC at all cabinet connection locations.

79-16.02C Pull Boxes, Junction Boxes, Terminal Cabinets/Boxes, and Enclosures**79-16.02C(1) General**

Use hinged door pull/junction boxes. Provide bonding jumpers between the door and the box or cabinet body on boxes and cabinets with hinged doors. Provide drains in the bottom of all enclosures.

Provide aluminum or steel mounting panels with corrosion resistant finishes, heavy duty terminal blocks for wire terminations, and uninsulated ground bars. Use copper ground bars for use with copper conductors.

Where boxes contain both power conductors and control conductors or fiber serving different devices, provide physical barrier(s) to separate the power and control conductors within the box.

In wet and damp locations, use surface-mounted boxes that comply with NEMA 250, UL 50, and NEMA 4X Type 316 stainless steel with stainless steel hinges and hardware.

In dry locations, use surface-mounted boxes that comply with NEMA 250, UL 50, and NEMA 12 carbon steel (minimum 14 gauge) with steel hinges and hardware.

79-16.02C(2) Terminal Cabinets and Terminal Boxes

Provide freestanding or wall mount style NEMA 4X, constructed of 12-gauge type 316 stainless steel (NEMA 12 carbon steel for dry locations only) terminal cabinets with an inner back plate for installing terminal blocks, fiber optic connector housings and panels, and other related components. Provide provisions for installing padlock with stainless steel hardware. Terminate all conductors and fibers, including spares, inside terminal cabinets. Provide all necessary mounting rails, end blocks, barriers, and accessories. Provide space on each side of

each terminal block to comply with NEC wiring bending requirements. Provide a permanent barrier or listed divider where power cables are terminated within the same cabinet as fiber optic cable.

79-16.02C(3) Control Cabinets

Provide freestanding or wall mount style NEMA 4X, constructed of 12-gauge type 316 stainless steel (NEMA 12 carbon steel for dry locations only) cabinet(s) with lockable hasp. Provide inner back plate for installing terminal blocks and all internal equipment. Terminate all conductors and fibers, including spares. Include humidistatically controlled heating, internal cabinet light, and terminal blocks. Install plastic wire duct to contain and organize internal wiring. The front door of the cabinet must feature the control panel layout with selector switches, pushbuttons, indicator lights, and other accessories.

79-16.02C(4) Variable Frequency Drive Cabinets

Variable frequency drive (VFD) cabinets must house the VFD and all related components. VFD cabinets must comply with the following requirements:

1. VFD cabinet must be heavy duty, free standing NEMA 12 industrial control enclosure constructed with a minimum of 12-gauge carbon steel.
2. Provide flange mounted disconnect switch for incoming power. Mechanically interlock the disconnect operator with the cabinet door and lock in the off position.
3. Provide a door activated internal LED cabinet light.
4. Provide a control power transformer mounted and wired inside the cabinet, sized as required by the cabinet components.
5. Install plastic wire duct to contain and organize internal control wiring.
6. The front door of the cabinet must feature the control panel layout with selector switches, pushbuttons, indicator lights, and other accessories.
7. Provide input line contactor.
8. Provide input line reactors, sized per drive manufacturer recommendation(s).
9. Provide high speed semi-conductor protection fuses sized per drive manufacturer recommendation(s).

79-16.02C(5) Terminal Blocks

Use heavy duty terminal blocks and power distribution blocks rated 600 volts (minimum 1000 volts for motor terminals), 90 degrees C, suitable for use with copper conductors, NEMA style, barrier type, tin plated copper, or aluminum, and Valox or phenolic insulated, with set-screw type terminals. Mount terminal blocks with stainless steel bolts or machine screws.

Within control enclosures, use finger safe, screw type connection with stainless steel corrosion resistant screws terminal blocks rated for minimum 300 volts, 15 amperes or terminal blocks as described above.

Provide printed or engraved labels for all terminals. Use color coded grounding type terminal blocks for ground conductors.

79-16.02D Mounting Brackets and Supports

79-16.02D(1) Fabricated Mounting Brackets and Supports

Use stainless steel type 316 for all stainless-steel plates, shapes (angles, channels, etc.), fabricated brackets, and similar items, unless otherwise noted.

For fabricated items which are constructed by welding, use steel per ASTM A 36, allow items to be thermally stress-relieved after welding and before any additional machining or finishing. Ensure welding complies with AWS standards appropriate for the material(s) and final product in question. Hot-dipped galvanize after fabrication.

Use type 316 stainless steel bolts, threaded rods, machine screws, nuts, washers, and similar hardware. Unless otherwise noted, use type 316 stainless steel concrete anchors with adhesive (epoxy) type anchor.

79-16.02D(2) Strut Channel

Unless otherwise noted, use strut channel to comply with the following requirements:

1. Strut channel and fittings manufactured in accordance with the requirements of the MFMA.
2. Type 316 stainless steel.

79-16.02E Power Distribution Equipment**79-16.02E(1) Automatic Transfer Switch and Generator****79-16.02E(1)(a) Automatic Transfer Switch**

Provide an automatic transfer switch (ATS), suitable for the 480 volt, three-phase, four-wire, solidly grounded neutral, electrical power source. ATS must be rated for 600A, 60 Hertz and housed in a NEMA 12, steel enclosure. Enclosure must feature double doors, comprised of a dead front door and an internal front door. Mount all controls to the internal door. Provide pad lockable external door. Use 4-pole transfer switch with silver allow contacts. The transfer switch mechanism must be electrically operated and mechanically held in position. Normal and generator contacts must be positively interlocked electrically and mechanically to prevent simultaneous closing. The ATS must have a microprocessor-based controller with a display for monitoring power conditions and adjusting transfer switch parameters. Features must include programmable engine start delay timer, engine stop delay timer, transfer delay timers, transition timer, and generator exerciser. The ATS must include indicator LED lamps for source availability, source connected, and exercise/test mode. The ATS must have a maintenance bypass/isolation switch that permits manual selection and connection of either source of power or power directly to load. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance. ATS must be compatible with generator control system and include all required external relays and contacts.

79-16.02E(1)(b) Generator

Provide a generator with power rating of not less than 500 kilowatt (KW) at 0.8 power factor, 480Y/277 volt, three-phase, 60 Hertz AC output.

Provide a Tier 4 rated diesel engine generator set with sub base fuel tank and all necessary accessories for proper fuel intake from the fuel tank. The capacity of the fuel tank must provide a minimum of 24 hours continuous run time at 25% load. Provide primary tank leak detection, low level fuel switch, and direct reading fuel level gauge for fuel tank.

Include an integrally mounted radiator cooling system. Include rodent barriers for all inlets and outlets.

House the engine generator set within a Level 3 sound-attenuated and weather protective powder coated steel enclosure with stainless steel hardware. Equip enclosure with exterior oil and coolant drains with interior valves for ease of service. Furnish the exhaust system with a residential grade silencer.

Equip the generator with heavy duty 12 or 24 volt DC negative ground battery(s) for engine starting, 100 amp battery charging alternator, and 120VAC battery trickle charger. Provide thermostatically controlled single phase heaters for the coolant system and alternator. Alternator must have class H insulation, and temperature rise of 125 degrees Celsius (standby).

Provide generator control system with total system integration, including automatic remote starting/stopping, precise frequency and voltage regulation, alarm and status message display, current protection, output metering, provisions for remote annunciator panel, and auto-shutdown at fault detection. Provide capability to start and run generator locally without transferring load.

Provide and install a remote annunciator panel for the generator at the control console. Include provisions to communicate up to 21 status indicators from the generator to the remote annunciator panel. Display generator operating and status indicators including, at a minimum, the following:

1. Common alarm.
2. Generator power.
3. Line power.
4. System ready.
5. Generator running.
6. Low oil pressure.
7. High coolant temperature.
8. Low fuel.
9. Low/high battery voltage.
10. Battery charger malfunction.

Provide all fuel required for the diesel generator set up through and including testing, and fill the fuel tank to full capacity after all testing and construction is completed and accepted by the Engineer.

Provide circuit(s) for generator accessories including coolant heater, alternator heater, and battery charger.

79-16.02E(2) Motor Control Center

Provide a motor control center (MCC), suitable for the 480 volt, three-phase, three-wire, 60 Hertz, electric power source. MCC construction must be totally enclosed, dead front, NEMA 12, free standing structures bolted together. All enclosing steel, wireways and unit doors must be gasketed. The manufacturer of the MCC must be ISO 9001 or 9002 certified.

Provide cabinet heaters and thermostats to prevent condensing humidity.

79-16.02E(2)(a) General Construction

The MCC structure must be a totally enclosed, dead-front, free-standing assembly made of 12-gauge formed steel channels, with 21 inch deep front-mounted units. Include a horizontal wireway at the top, isolated from the horizontal bus via metal barriers and readily accessible through a hinged cover. Include a horizontal wireway at the bottom that is open to the full rear of the structure. Provide adequate space for conduit and wiring to enter the bottom without structural interference.

Coordinate shipping splits and lifting provisions with the manufacturer so that the MCC can be safely transported to and installed on-site without damage.

For each unit, provide an individual door giving access to only that unit. Doors must have concealed hinges. Cover all unused openings with removable blank doors.

For each combination motor starter unit, use circuit breaker with flange mount external operating handles, lockable in the OFF position.

Mount an operating mechanism on the primary disconnect of each unit and mechanically interlock with the unit door to prevent access, unless the disconnect is in the off position. Provide a defeater to bypass the interlock. Provide an interlock to prevent inadvertent closing of the disconnect with the door open. Provide a second interlock to prevent removal or reinsertion of the unit while in the on position. Provide padlocking facilities to positively lock the disconnect in the off position with up to three padlocks with the door open or closed.

Include an engraved nameplate on the incoming line section with the MCC serial number, system electrical data, bus ampacity, and the bus short circuit rating.

Attach engraved plastic nameplates with 1/4-inch white text on black background bearing the name of the equipment served to each unit with stainless steel machine screws. Label each contactor, relay, and circuit breaker with its own engraved nameplate located adjacent to the corresponding device.

79-16.02E(2)(b) Motor Control Center Bus

The MCC structure must contain a main horizontal tin-plated copper bus, with minimum ampacity of 600 amperes. Use vertical bus feeding unit compartments that are tin-plated copper and securely bolt to the horizontal main bus. Use front-accessible joints for ease of maintenance. The vertical bus must have a minimum rating of 600 amperes. Both vertical and horizontal bus must be fully rated and cannot be tapered.

Bus must be braced for 65,000 RMS symmetrical amperes.

Secure the tin-plated copper ground bus to each vertical section structure for the entire length of the MCC.

Each structure must contain a tin-plated vertical ground rated 300 amperes. Connect the vertical ground bus directly to the horizontal ground bus via a tin-plated copper connector. Connect each unit to the vertical bus via a tin-plated copper stab.

79-16.02E(2)(c) Wiring and Terminations

Use NEMA Class II, Type C wiring.

79-16.02E(2)(d) Combination Motor Starter Units

Use NEMA size reversing or non-reversing type overload motor starter units with manual reset.

Use circuit breakers that comply with section 79-16.02E(3) with a minimum interrupting capacity of 65,000 amperes.

The front door of each unit must feature selector switches, pushbuttons, indicator lights, and other accessories.

Motor Circuit Protectors (MCP) must contain magnetic type circuit breaker with a permanent trip unit containing individual magnetic trip element in each pole. MCP's must be suitable for mounting and operating in any position. Use mechanical screw type lugs rated for copper conductors and 90 degrees Celsius. Use MCP's to supply motor loads within a combination motor starter.

79-16.02E(3) Circuit Breakers

Use molded case circuit breakers that utilize toggle-type trip-free operating mechanisms, with quick-make, quick-break action, and positive handle indication. Circuit breaker operating handles must assume a center position when tripped. Use common-trip two-pole and three-pole breakers.

Equip a permanent trip unit with each thermal-magnetic type circuit breaker containing individual thermal and magnetic trip elements in each pole. Use circuit breakers suitable for mounting and operating in any position. Use bolt-on connections to the bus. Use mechanical screw type lugs rated for copper conductors and 90 degrees C.

Use NEMA 4X, type 316 individually mounted enclosed circuit breakers. Use enclosures with hinged doors, provisions for attaching a padlock, external operating handles lockable in the OFF position, and mechanical door interlocks.

79-16.02E(4) Control Transformers

Provide totally encapsulated control transformers to limit control circuit loading from full voltage contactors and motor starters. Use minimum 65 VA transformers with primary and secondary fuses in accordance with the NEC. Feed transformers from the load side of the contactor's disconnecting means. Serve only one contactor from each transformer.

79-16.02E(5) Surge Protection Devices

Use heavy duty surge protection devices (SPD) that comply with *UL 1449* and *UL96A* master label. SPDs must provide line-to-line, line-to-neutral, line-to-ground, and neutral-to-ground protection. Include LED indicators for "Loss of Protection" and "Fully Operational", an audible fault alarm with test/silence switch, and one set of normally open and normally closed dry contacts. SPDs must provide *UL* label 200kA short circuit rating, type 1 or 2 protection, intended for use with need for external or supplemental overcurrent controls. Provide voltage protection ratings per the application and other ratings to comply with sections 79-16.02E(5)(a) and (b).

79-16.02E(5)(a) Motor Control Center SPD

SPD (Type 2) integral to the MCC and mounted inside a designated unit. SPD surge current capability of at least 150,000 amperes per phase, or to comply with NEC and NFPA requirements.

79-16.02E(5)(b) Panelboards SPD

SPD(s) (Type 2) integral to the panelboard directly connected to the bus between the mains and the branch circuit breakers. SPD surge current capability of at least 100,000 amperes per phase, or to comply with NEC and NFPA requirements.

79-16.02E(6) Lightning Protection System

Provide lightning protection system (LPS) components to comply with *UL 96*, *NFPA 70*, *NFPA 780*. Provide *UL* master label certified LPS design and components. Engage the services of a *UL* master label certified LPS designer and installer to design and submit the proposed lightning protection system components and layout to the Engineer for review and approval, and to install the approved LPS. Coordinate the location, layout, and installation methods with the general contractor and bridge structure. Use LPS components to comply with the following requirements.

79-16.02E(6)(a) Air Terminal (Lightning Rod)

Provide copper or aluminum air terminals not less than 24" long. Use air terminal base supports with connector fitting(s) for connection of the lightning (down) conductor.

79-16.02E(6)(b) Down Conductor

Connect the air terminal to the grounding electrode with the down conductor. Use a copper or aluminum down conductor not less than 115,000 circular mils at 375 lbs. per 1000 ft for copper and not less than 192,000

circular mils at 190 lbs. per 1000 ft for aluminum. Use copper or aluminum secondary or bonding conductors not less than 26,240 circular mils for copper and not less than 41,100 circular mils for aluminum. Provide beam clamps, suitable for use with down conductors, for attaching the down and secondary conductors to the existing steel structure. Provide brass round conductor clamp brackets for attaching the down conductor to the concrete pier. Utilize adhesive anchors, size and length per bracket manufacturer, to attach the bracket to the pier.

79-16.02E(6)(c) Grounding Electrode

Connect the grounding electrode to the down conductor. Use a grounding electrode not less than 5/8" diameter and 8 feet in length. Use a copper-clad steel constructed electrode and extend vertically not less than 10 feet into the earth. Provide copper or brass connectors for attaching the grounding electrode to the down conductor.

79-16.02E(7) Power Monitor

Provide an AC power monitor with built-in display, capable of measuring 3-phase voltage, current, and power, compatible for the 480 volt AC, 3-phase system of the bridge. Include programming software or embedded web server for device setup and viewing. Mount the device in a MCC unit with its display panel on the unit door. Provide potential transformers and current transformers for connections of the device to the bridge AC power system. The power monitor must contain internal relay contacts, double-pole, double throw (DPDT) style, rated at 5 amperes at 240 volts AC, 60 hertz, for use as inputs to the PLC in the event of a phase failure or phase reversal.

79-16.02E(8) Panelboards

Provide NEMA 12 surface-mounted circuit breaker panelboards equipped with thermal-magnetic molded case circuit breakers. Provide access covers with a pad lockable hinged door. Cover all live parts with trims.

Utilize "distributed phase" or "phase sequence" type bus bar connections to the branch circuit breakers. Install single-phase, three-wire bussing such that only one adjacent single-pole breaker is individually connected to each of the two different phases in such a manner that one-pole or two-pole breakers can be installed at any location. Use tin-plated copper for all current carrying parts of the bus assembly. Include a system ground bus in all panels.

Mark panelboards with their maximum short circuit current rating at the supply voltage. Use 90 degrees Celsius rated terminals for conductors to the panelboard mains and branch circuit wiring. Provide a circuit directory frame and a card with a clear plastic covering on the inside of the door. Provide a minimum 1/4 inch space by three inches long, or equivalent, for each circuit on the directory card. Typewrite the directory to identify the load fed by each circuit.

Protect each panelboard with a SPD, installed directly inside, or mounted immediately adjacent to the panelboard. Use a SPD rated for the specific voltages of the corresponding panelboard and to comply with section 79-16.02E(5). Use a SPD product of the same manufacturer as the panelboard and breakers.

Use branch circuit breakers with minimum short-circuit rating of 10,000 amperes symmetrical at 240 volts, and 14,000 amperes symmetrical at 480 volts. Provide bolt-on type, heavy-duty, quick-make, quick-break, single or multi-pole circuit breakers for each circuit with toggle handles that indicate when the unit is tripped. Use thermal-magnetic type circuit breakers with common handle for multiple pole circuit breakers. Use circuit breakers with minimum 100-ampere frame; ratings through 100-ampere trip must take up the same pole spacing.

79-16.02E(9) Transformers

Provide dry-type totally enclosed non-ventilated transformers with a NEMA 12 rated enclosure, copper windings, insulated with a 220 degrees C insulation system and rated at 115 degrees C temperature rise. Equip transformers with two 5% Full Capacity Below Nominal (FCBN) taps.

79-16.02E(10) Disconnect Switches

Provide heavy duty, non-fusible, 3-pole, safety disconnect switches. Utilize quick-make, quick-break contacts, with terminals sized per the incoming and outgoing conductor(s). Use stainless steel, NEMA 4X enclosures with external operating handles, lockable in the OFF position, and mechanical door interlocks.

79-16.02F Lighting and Receptacles**79-16.02F(1) Maintenance Receptacles**

Provide industrial specification-grade extra heavy-duty self-test GFCI (ground fault circuit interrupter) receptacles rated for 120 VAC, 60 HZ, 20 amperes, with NEMA 5-20R receptacle configuration. Provide tamper and weather resistant receptacles complete with all required accessories including stainless steel, NEMA 4X while-in-use weatherproof box/cover (for wet and damp locations) and mounting hardware.

79-16.02F(2) Maintenance Lighting Fixtures

Provide an UL 1598 listed heavy duty LED lighting fixture, style as detailed on the Plans. Provide fixtures complete with all required accessories including mounting hardware to supplement building structure for support of fixtures. Comply with all of the additional features as shown on the Plans.

79-16.02F(3) Light Switches

Use extra heavy duty, corrosion resistant light switches rated for 20 amperes and 120 volts. Use NEMA 4X, stainless steel watertight box and cover.

79-16.02F(4) Pier Navigation Light

Provide heavy duty, marine type design pier navigation lights with rain-tight, fully gasketed, cast aluminum housing. Provide pier navigation lights that comply with all Coast Guard recommendations and requirements.

Provide pier navigation lights with vandal resistant features including stainless steel tamper resistant external fasteners and lens guard formed of expanded stainless steel to provide protection from projectiles such as rocks or other thrown objects.

Include a tempered Fresnel glass lens red in color with nominal lens section of 180 degrees and inside and outside lens diameters of 7" and 8", respectively.

Include a 120-volt, single medium base LED lamp with 100,000-hour lamp rating. Provide a dual lamp arrangement with automatic transfer relay to switch power to the backup lamp upon failure of the primary lamp. Include a second independent contact for remote signaling of primary lamp failure status. Contain relay components in a cast box of the same material as the fixture head.

Include a pre-wired rectifier as part of the light assembly to increase lamp life.

Provide a base cast of the same material as the fixture head (aluminum). Mount the light assembly with four ½ inch diameter bolts, or as specified elsewhere herein, through the base.

79-16.02F(5) Lift Span Navigation Light

Provide heavy duty, marine type design lift span navigation lights with rain-tight, fully gasketed, cast aluminum housing with one red light over one green light in a vertical arrangement. Provide lift span navigation lights that meet or exceed all Coast Guard recommendations and requirements.

The lift span navigation light design shall provide ready access for lamp service. Provide cast junction box with gasketed access cover of same material as light assembly.

Suspend the light heads from a 1-1/2" galvanized steel schedule 40 pipe, length as required per the Contract drawing details. Provide a swivel design for all wiring to be completely contained within the light assembly. Provide gaskets and O-rings for a weather-tight assembly. Provide a swivel of heavy-duty construction, cast of the same material as the fixture head with a stainless-steel spindle.

Provide an automatic latch to hold the light securely in the normal operating and service positions. Ensure the service chain will automatically release the latch with a firm pull, allowing the light to pivot, and as the latch is raised, the latch will automatically engage to hold the light in the service position.

Include a tempered Fresnel glass lens red in color with nominal lens section of 180 degrees and green in color with nominal lens section of 360 degrees. Inside and outside lens diameters shall be 7" and 8", respectively.

Include a 120-volt, single medium base LED lamp with 100,000-hour lamp rating. Provide a dual lamp arrangement with automatic transfer relay to switch power to the backup lamp upon failure of the primary lamp for both lamp sections. Include a second independent contact for remote signaling of primary lamp failure status. Contain relay components in a cast box of the same material as the fixture head.

Include a pre-wired rectifier as part of the light assembly to increase lamp life.

79-16.02G Control System Components

79-16.02G(1) Programmable Logic Controller System

Provide a programmable logic controller (PLC) system with the following features, components, and capabilities:

1. Two identical PLC processors for redundancy, each with its own dedicated power supply. Provide a selector switch to manually select processor A or processor B.
2. Supports communication options for up to 60 Ethernet/IP nodes and up to 31 local input/output modules.
3. 3 MB or greater user memory.
4. Provide SD card(s) with non-volatile memory for backup of PLC program in the event of a loss of power.
5. Operating temperature and relative humidity range of 0 to 60 degrees Celsius and 5 to 95 percent noncondensing.
6. Digital/discrete input and output, analog input and output, communications, special purpose modules, resolver modules, cables, and power supplies.
7. Input and output modules from the same product series as the PLC processor.
8. 120 volts digital input/output modules. Provide a minimum of 20 percent spare points for digital inputs and outputs or eight (8) digital input and eight (8) digital output points, whichever is greater, in each cabinet.
9. Use a dedicated and independent communication network from other communications network(s) for I/O communications between racks.
10. Install all necessary PLC programming software and accessory programs including communications drivers and programming documentation editors. License all software to the Owner.

79-16.02G(2) Ethernet Switch

Provide industrial managed type Ethernet switches that comply with the following:

1. Rack mount type or DIN rail mount with all necessary hardware and brackets for mounting.
2. Provide minimum number of ports for the connected equipment plus one spare port per switch. Provide dynamic host configuration protocol (DHCP).
3. Provide minimum of two small form-factor pluggable (SFP) fiber optic ports fully compatible with fiber optic cable and connector type(s).
4. All Ethernet RJ45 and fiber optic ports must support Gigabit Ethernet speeds or higher.
5. Supports the use of industrial automation protocol Ethernet/IP (bridge control system switches only), and other protocols as required for compatibility with PLC, CCTV and PA system equipment, and other connected devices.
6. Supports the use of rapid spanning tree protocol (RSTP) 802.1w, IEEE 802.1x security standard for access control and authentication, simple network management protocol (SNMP) version 3, IEEE802.1q, quality of service (QoS) prioritization, and internet protocol version 4 or version 6 (IPv4 or IPv6).
7. Provide ethernet switches capable of being configured via integrated web server.
8. Provide alarm LED indicator and contact.
9. Provide memory card slot to backup configuration data and to provide Layer 2 or 3 functions, with a spare configured card.
10. Provide operating temperature range of 0 to 60 degrees Celsius.

79-16.02G(3) Power over Ethernet Switch

Provide industrial managed type Power over Ethernet (PoE) switches that comply with the following:

1. Rack mount type or DIN rail mount with all necessary hardware and brackets for mounting.
2. Provide minimum number of ports for the connected equipment plus one spare port per switch. Provide up to IEEE 802.3bt type 4 PoE+ ports (as required) and sufficient wattage for each switch to power all PoE+ devices connected. Provide dynamic host configuration protocol (DHCP).
3. Provide minimum of two small form-factor pluggable (SFP) fiber optic ports fully compatible with fiber optic cable and connector type(s), where required.
4. All Ethernet RJ45 and fiber optic ports must support Gigabit Ethernet speeds or higher.
5. Supports protocols as required for compatibility with CCTV and PA system equipment, and other connected devices.
6. Supports the use of rapid spanning tree protocol (RSTP) 802.1w, IEEE 802.1x security standard for access control and authentication, simple network management protocol (SNMP) version 3, IEEE802.1q, and internet protocol version 4 or version 6 (IPv4 or IPv6).

7. Provide ethernet switches capable of being configured via integrated web server.
8. Provide alarm LED indicator and contact.
9. Provide memory card slot to backup configuration data and to provide Layer 2 or 3 functions, with a spare configured card.
10. Provide operating temperature range of 0 to 60 degrees Celsius.

79-16.02G(4) Uninterruptible Power Supply

Provide rack or DIN rail mount uninterruptible power supplies (UPS) for bridge control system, CCTV system, and public address system equipment. Provide UPS to sustain operation during short-term power failures and power for an orderly shutdown to prevent loss of data during power failure.

Size the UPS to sustain a connected full load for a minimum of 5 minutes, or enough time for generator transfer, in the operating environment. Submit UPS sizing calculation with UPS product data submittal. For each UPS, include tabulation of connected load, run-time at full load, run-time at total connected load, and expected shut-down time for connected equipment in calculation. Provide a UPS to comply with the following additional requirements:

1. Suitable for standard EIA-310 rack mounting or DIN rail mounting.
2. Microprocessor controlled with LED or LCD status display.
3. Audible and visual alarms.
4. Computer grade sine wave power with 5 percent or less total harmonic distortion.
5. Regulated output to 120 V(ac) $\pm$ 3%
6. Frequency regulation $\pm$ 5% synchronized to utility, $\pm$ 0.5 Hz on battery.
7. Operating temperature range of -25 to 60 degrees Celsius for UPS located in outdoor/exposed enclosures; operating temperature range of 0 to 40 degrees Celsius for UPS in enclosures located in indoor (temperature controlled) areas.
8. Relative humidity operation range 0-90%.
9. Built in battery charger, with battery management to extend battery life.
10. Internal maintenance free, sealed type batteries.
11. Provisions for adding additional external batteries.
12. Lightning and surge tested to comply with ANSI/IEEE C62.41.
13. Forced air cooled by an internally mounted fan(s).
14. 10/100Mbit Ethernet communication option.

79-16.02G(5) Pushbuttons and Signaling Devices

79-16.02G(5)(a) General

Use industrial type, 30.5 millimeter, metal NEMA 4/13 rated devices with corrosion resistant screw type terminals.

79-16.02G(5)(b) Indicator Lights

Use replaceable type full voltage LED, 120 volts AC lamps.

79-16.02G(5)(c) Pushbuttons

Use pushbuttons with screw down stackable contact blocks and contacts rated for 10 amperes at 120 volts AC.

79-16.02G(5)(d) Selector Switches

Use selector switches with screw down stackable contact blocks and contacts rated for 10 amperes at 120 volts AC. Provide minimum 10 spare keys for key switches.

79-16.02G(6) Limit Switches

79-16.02G(6)(a) Proximity Limit Switch

Provide magnetic style proximity switch constructed of stainless steel with NEMA 4X or 6P corrosion resistant ratings. Provide double-pole double-throw (DPDT) contacts with minimum ratings of 10 amperes, 120 volts AC. Provide switch with operating temperature of -40 to 105 degrees Celsius. Proximity switch must provide a min. 1/4" sensing distance against ferrous materials. Provide a target magnet as required to increase sensing distance. Choose sensing face and orientation to comply with the installation location. Provide factory installed cord set with matching quick disconnect connector.

79-16.02G(6)(b) Lever Arm Limit Switch

Provide heavy-duty NEMA style lever arm limit switches constructed of zinc die cast or stainless steel with NEMA 4X or 6P corrosion resistant and IP67 ingress protection ratings. Provide double-pole double-throw (DPDT) contacts with minimum rating of 10 amperes, 120 volts AC. Provide switch with operating temperature of -40 to 105 degrees Celsius. Provide corrosion resistant lever arm and use factory installed cord set with matching quick disconnect connector.

79-16.02G(6)(c) Rotary Cam Limit Switch

Provide NEMA style rotary cam limit switch with cams/switches and integral resolver. Provide shaft configuration and gear reducer as required by application. Provide cam limit switch with 0 to 500 revolutions per minute (RPM) rated switching speed, bidirectional and snap action DPDT contacts, rated for 10 amperes, 120 volts AC. Provide the cam limit switch with an operating temperature rating of -50 to 185 degrees Fahrenheit and minimum cam adjusting temperature of -10 degrees Fahrenheit. Provide NEMA 4X, stainless steel enclosure for rotary cam limit switch. Provide resolver integral to the rotary cam limit switch assembly and enclosure. Provide industrial grade resolver with single turn and absolute position. Interface the resolver with the PLC control system.

Provide rotary cam limit switch support and incidentals.

79-16.02G(7) Relays**79-16.02G(7)(a) Control Relays**

Provide heavy-duty, UL listed industrial, NEMA machine tool relays with continuous contact rating of 10 amps at 600 volts AC, AC make/break rating of NEMA A600. Provide minimum number and type of contacts as shown on the Plans and to complete a fully functional control system.

79-16.02G(7)(b) Interposing Relays

Use interposing (isolation) relays for interfacing with drives and motor controls, interfacing with other systems, and for isolating PLC inputs and outputs. Provide general purpose plug-in type tube or blade style relays with DPDT contacts rated 10 amperes at 300 volts AC, 60 hertz. Provide 120 volts AC, 60 hertz relay coils or as required by application. Provide DIN rail or panel mounting relay with retainer clips and LED indicator light, or a mechanical flag indicator for indicating when the relay is energized.

79-16.02G(8) Boat Detection Sensors

Provide light detection and ranging (Lidar) sensors capable of detecting marine traffic that complies with the following requirements:

1. IP 65 rating or approved equivalent, outdoor housing, impact resistant, shock resistant, and vibration resistant.
 2. Class 1 laser.
 3. 120° minimum scanning aperture.
 4. Software programmable.
 5. 24VDC power input.
 6. Digital output for communication to the PLC.
 7. 200' minimum horizontal measuring range.
 8. Provide minimum operating temperature range of -10°C to +50°C.
 9. For mounting screws, provide screw locking devices to ensure vibration does not cause sensor to come loose from mounting bracket.
 10. Provide mounting kits 1, 2, and 3 for mounting hardware.
 11. Program sensor software to utilize evaluation fields which cover the area horizontally out from the pier and inboard towards the maximum extent of sensor field of view angle to a distance of 152'.
 12. Provide larger of manufacturer available weather protection hoods.
- Provide long range distance sensor capable of detecting marine traffic that complies with the following requirements:

1. IP 65 rating or approved equivalent, impact resistant, shock resistant, and vibration resistant.
2. Class 1 laser.
3. Software programmable.
4. 24VDC power input.
5. Digital output for communication to the PLC.

6. 300' minimum horizontal measuring range.
7. Provide minimum operating temperature range of -10°C to +50°C.
8. Provide manufacturer weatherproof housing and mounting bracket.
9. Provide appropriate fasteners to ensure vibration does not cause sensor to come loose from mounting bracket.

79-16.02G(9) Inclinator

Provide a 2-dimensional (for longitudinal and transverse skew), self-contained inclinometer for detecting span tilt conditions, that complies with the following:

1. 4-20mA analog output for communication to the PLC
2. IP65, high impact, shock, and vibration resistant.
3. -40 to 80 degrees C operating range
4. Min. ±5-degree measurement range at .001-degree resolution
5. Waterproof quick disconnect connector and matching cord set.
6. Provide all necessary software and programming cables.

79-16.02G(10) Human Machine Interface

Provide a purpose-built rugged, panel mountable HMI with 10" minimum full color resistive analog touchscreen. Provide HMI with rugged aluminum housing with operating temperature range of -20 to 60 degrees Celsius. Provide Ethernet, USB, and serial ports as required for communication with devices and support up to 20 simultaneous protocols. Provide built-in data logging with time stamp capability to store and display a complete history of bridge alarms and faults. Provide other accessories and options as required to satisfy all operational requirements as specified elsewhere herein. The HMIs shall be capable of supporting and displaying the GUI screen(s) as described in Section 79-16.03O SCADA System.

79-16.02G(11) VPN Router

Provide a VPN router in the Operator House and connected to the local network connection entrance point, capable of supplying a secure, Virtual Private Network (VPN) connection to the PLC control system and CCTV. In addition, the router shall meet the following requirements:

1. Min. 2 VPN tunnels with required username and password for web-based access and management.
2. Integrated managed ethernet switch with min. 4 RJ45 ports, 10/100BASE interface.
3. USB connection programming port.
4. Supports Dynamic Host Configuration Protocol (DHCP) and Network Time Protocol (NTP).
5. DIN rail mountable.
6. IPSEC protocol on Layer 3 security protection.

79-16.02H Closed-Circuit Television System

79-16.02H(1) General

Provide a closed-circuit television (CCTV) system using the most current version of system protocol and software at the time of installation. Provide compatible system components.

Provide Ethernet and PoE switches to comply with sections 79-16.02G(2) and (3).

79-16.02H(2) Network Video Recorder

Provide a network video recorder (NVR) that is configurable via the use of one central GUI (Graphical User Interface). Supply a standard mouse and keyboard with the NVR for system configuration and management. Provide an NVR to comply with the following:

1. 16 or more IP video streams.
2. Redundant RAID storage system for IP video streams, playback, and export.
3. Solid state drive (SSD) for operating system storage to increase responsiveness.
4. Support recording in JPEG, MPEG-4, and H.264 IP streams.
5. Support H.264 Megapixel video streams up to 8 Megapixel resolution.
6. Automatic detection of IP cameras.
7. Operation on a 4th Generation Intel Xeon processor or later and minimum 4 GB of RAM.
8. Windows 10 (or later) Ultimate 64-bit operating system.
9. Support of monitor walls, including cell layouts and cameras.
10. Supports attached storage (NAS) to extend video retention and ability to export recorded segments.

11. Support of Lightweight Directory Access Protocol (LDAP).
12. System Requirements:
 - 12.1. Network Interface: Gigabit Ethernet (1000Base-T) ports (2x)
 - 12.2. Processor: Intel Core i5 64-bit CPU
 - 12.3. Internal Storage: 48 TB min., RAID-5 hot swappable drives
 - 12.4. USB Ports: 2 USB 2.0 ports / 1 USB 3.0 ports
 - 12.5. Power Input: 100 to 240 volts AC, 60 Hz, auto ranging, internal power supply
 - 12.6. Recording Throughput: Up to 450 Mbps
 - 12.7. IP Version: IPv4 and IPv6
13. Video Requirements:
 - 13.1. Video System: NVIDIA Quadro P1000 (4 GB memory)
 - 13.2. Maximum Resolution: mDP 1.4 direct connect, HDR 5120 x 2880 at 60 Hz
14. Environmental Requirements:
 - 14.1. Operating Temperature: 10°C to 35°C
 - 14.2. Operating Humidity: 20% to 80%, noncondensing
15. Other Requirements:
 - 15.1. Remote viewing and monitoring of live and recorded video via a desktop application or Web browser with all required security protocols.

79-16.02H(3) Pan-Tilt-Zoom (PTZ) Camera

Use outdoor vandal and tamper resistant dome type with an impact resistance rating of K10 (20 Joules). Provide camera with interior heater and rated IP67, -40°C to 60°C operating temperature, 10 to 90% RH condensing operating humidity, and shock and vibration resistant, complying with NEMA 4X and TS-2 paragraph 2.2.7-2.2.9.

Provide integrated Varizoom IR 200 meter to see in total darkness.

Provide SureVision (or equivalent) technology including up to 130 dB wide dynamic range, advanced low light down to 0.035 lux (color) and 0.0195 lux (monochrome), and anti-bloom technology.

Provide progressive 1/1.8-inch CMOS sensor, up to 3840x2160 resolution at 30 frames per second, f/1.5 to f/3.4, 6.36-127mm focal length. Provide H.264 and MJPEG compression formats available for primary and secondary streams with selectable Unicast and Multicast protocols.

Provide min. 20x optical zoom and 12x digital zoom and delivering full frame rate HD images over the entire zoom range. Include a variable hi-speed pan and tilt drive, with 360° continuous pan and +30° to -90° tilt with additional features allowing user programmable preset viewing angles. Preset accuracy for pan and tilt function shall be within ±0.03°.

Provide supported network protocols for integration into CCTV system. Provide a full function web server, allowing complete administrative and operator control capabilities. Administrative features shall include configuring network settings, user password assignments, setting video stream properties, configuring camera imaging properties, and assigning camera ID labels.

Provide compatible camera mounting accessories as required for structure mount and other camera installation as shown on the Plans.

Provide robust image stabilization assuring a steady, clear image for installations subject to wind or vibration, allowing existing bridge structures to be used for camera mounting.

Support industry standard Power over Ethernet (PoE+) IEEE 802.3bt to supply power to the camera (with heaters on) over the network with RJ-45 connector for 100Base-TX and 1000Base-Tx.

79-16.02H(4) Thermal Camera

Use outdoor vandal and tamper resistant dome type with an impact resistance rating of K10 (20 Joules). Provide camera rated IP66 and NEMA 4X, -40°C to 65°C operating temperature, and 0 to 90% non-condensing operating humidity.

Provide multiple video stream capability; two independently configured H.264 or H.265 streams.

Provide an uncooled VOx microbolometer image sensor with 12 micrometer pixel pitch and 8 to 14 micrometer spectral range. Imaging rate must be up to 30 frames per second.

Provide compatible camera mounting accessories for structure mounting.

Provide supported network protocols for integration into CCTV system. Provide a full function web server, allowing complete administrative and operator control capabilities. Administrative features must include configuring network settings, user password assignments, setting video stream properties, configuring camera imaging properties, and assigning camera ID labels.

Support industry standard Power over Ethernet (PoE+) IEEE 802.3af, Class 3 to supply power to the camera (with heaters on) over the network with RJ-45 connector for 100Base-TX.

79-16.02H(5) Fixed Camera

Use outdoor vandal and tamper resistant dome type with an impact resistance rating of K10 (20 Joules). Provide camera rated IP67, -40°C to 60°C operating temperature, 0 to 95% non-condensing operating humidity, and shock and vibration resistant, complying with NEMA 4X and TS-2 paragraph 2.2.7-2.2.9.

Provide SureVision (or equivalent) technology including up to 130 dB wide dynamic range, advanced low light down to 0.03 lux (color) and 0.008 lux (monochrome).

Provide progressive 1/1.8-inch progressive scan CMOS sensor, up to 3840x2160 resolution at 30 frames per second. Provide H.264 and MJPEG compression formats available for primary and secondary streams with selectable Unicast and Multicast protocols.

Provide supported network protocols integration into CCTV system. Provide a full function web server, allowing complete administrative and operator control capabilities. Administrative features must include configuring network settings, user password assignments, setting video stream properties, configuring camera imaging properties, and assigning camera ID labels.

Provide compatible camera mounting accessories for structure mounting.

Support industry standard Power over Ethernet (PoE+) IEEE 802.3at, Class 4 to supply power to the camera over the network with RJ-45 connector for 100Base-TX and 1000Base-Tx.

79-16.02H(6) Wall Mount Monitor

Provide industrial ultra high-definition LED monitors for viewing cameras that comply with the following:

1. Minimum 49-inch diagonal screen with LED backlight.
2. Ultra HD (3840 x 2160) resolution, 16:9 aspect ratio.
3. Response time of 8ms or faster.
4. Ultra-wide 178° (H) / 178° (V) viewing angle.
5. Minimum brightness rating of 450 cd/m2.
6. Operating temperature: 0°C to 40°C (32F to 104F).
7. HDMI, DVI, VGA, and S-Video inputs (coordinate with NVR outputs).
8. 100–240 volts, 50/60 Hz power.
9. VESA mountable.

Provide heavy duty ceiling or wall mount mounting bracket with mounting hardware. Secure mounting bracket to a sturdy structural member. Provide power and video cables and all required accessories.

79-16.02H(7) Surge Protection Device

Provide a PoE surge protection device rated for Gigabit high PoE for each camera power over Ethernet connection with the following minimum requirements:

1. UL497B listed.
2. Provide transmission speeds up to and including 1000BaseT.
3. Total discharge current rating of 10 kiloamperes at 8/20 microseconds, 10 times with 3 minute intervals.
4. Peak pulse current rating of 100 amperes at 10/1000 microseconds, 300 times with 3 minute intervals.
5. Differential and common mode protection.
6. Operating temperature range of -25 to 60 degrees Celsius.

79-16.02I Public Address System**79-16.02I(1) General**

Provide a public address (PA) intercom system using the most current version of system protocol and software at the time of installation. Provide compatible system components.

Provide Ethernet and PoE switches to comply with sections 79-16.02G(2) and (3).

79-16.02I(2) IP Controller

Provide PoE IP controller that complies with the following:

1. SIP telephone interface compatibility.
2. Operating temperature range of -20 to 55 degrees Celsius.
3. Support industry standard Power over Ethernet (PoE+) IEEE 802.3at, Class 4 to supply power to the IP Controller over the network with RJ-45 connector for 100Base-TX and 1000Base-Tx.

79-16.02I(3) Desktop Intercom

Provide PoE desktop intercom that complies with the following:

1. RFC3261-compliant SIP telephone interface.
2. Integral speaker.
3. Programmable alarms and recordings.
4. Touchscreen.
5. Separate communication zones.
6. Operating temperature range of 0 to 50 degrees Celsius.
7. RJ-45 connector for 100Base-TX and 1000Base-Tx.

79-16.02I(4) Handset Intercom

Provide handset intercoms that comply with the following:

1. SIP telephone interface.
2. Separate communication zones.
3. Operating temperature range of -30 to 60 degrees Celsius.
4. RJ-45 connector for 100Base-TX.

79-16.02I(5) Speaker Amplifier

Provide speaker amplifiers that comply with the following:

1. Multicast communication zones.
2. Operating temperature range of -30 to 60 degrees Celsius.
3. RJ-45 connector for 100Base-TX and 1000Base-Tx.

79-16.02I(6) Large Horn Speaker

Provide outdoor horn speakers that comply with the following:

1. Corrosion and weather resistant.
2. Type 316 stainless steel hardware.
3. Operating temperature range of -40 to 70 degrees Celsius.

79-16.02J Main Drive System**79-16.02J(1) Main Drive Motor**

Provide main drive inverter duty rated motor(s) that comply with the following:

1. 460 volts AC, 3 phase, 60 Hertz.
2. Minimum duty cycle rating of 5 minutes at 3 to 5 Hertz, 15 minutes at 6 to 15 Hertz, and 60 minutes at 16 to 60 Hertz, with a service factor of 1.15 at constant speed.
3. Optimized for operation with a variable frequency flux vector drive.
4. NEMA MG 1, Part 31.
5. Include factory mounted incremental encoder with at least 1024 pulses per revolution and output interface for compatibility with the supplied variable frequency drive.
6. Include 120-volt internal space heater.

79-16.02J(2) Main Drive

Provide a flux vector AC variable frequency (main) drive (VFD) featuring true field-oriented flux vector control. Use VFDs rated 480 volts AC, 60 hertz, three-phase, 100 horsepower, heavy duty, and capable of providing

true closed loop (encoder feedback) flux vector speed and torque control. Provide VFDs that comply with the following:

1. Microprocessor based control.
2. Operator interface, with backlit LCD display and keypad, usable for drive status monitoring and entry of all drive parameters. The operator interface must include all necessary cables and hardware required to mount it on the VFD cabinet door. All parameters must be viewable and adjustable through the drive operator interface and with the drive manufacturer's software package. Parameters must be stored in nonvolatile memory. Mount VFD operator interface on cabinet door to use and view without opening the VFD cabinet.
3. Include built-in communications capability, including Ethernet with common industrial protocol. Use Ethernet communications connection for VFD configuration.
4. Three preset speeds selectable via external discrete control inputs, independently adjustable acceleration and deceleration times, and adjustable torque limit selectable via external discrete control input to allow for a reduced bridge seating torque.
5. Internal, adjustable electronic thermal overload relay for motor overload protection.
6. Self-tuning feature allowing the VFD to optimize its performance parameters to the main drive motor.
7. 0 to 40 degrees Celsius operating temperature without derating and 5-95% relative humidity operation range, non-condensing.
8. Speed regulation with slip compensation in sensor less vector mode of 0.5% of base speed across 40:1 speed range, 40:1 operating range.
9. Speed control with feedback (flux vector mode) of 0.001% of base speed across 100:1 speed range, 1000:1 operating range.
10. Adjustable carrier frequency with a minimum of four settings.
11. Safe torque off function, to safety category 3, Safety Integrity Level (SIL) CL3 or higher.
12. 150% rated motor full load torque for 60 seconds, 180% for three seconds.
13. Provide the drive manufacturer's software package and necessary programming cables for the configuration, backup, and restoration of drive parameters. Install the software package on the laptop computer and license to the Owner.

79-16.02J(2)(a) Main Drive Input Line Reactors

Provide VFD input line reactors that comply with the following:

1. NEMA Type 1 enclosure.
2. 3% impedance based on the fundamental current rating, or as otherwise recommended by the drive manufacturer.
3. Overload rating of 200% of fundamental current for 30 minutes and 300% of fundamental current for 1 minute.
4. dV/dt protection in accordance with NEMA MG-1, part 31.
5. Suitable for operation on 480 volts AC, 60 hertz, three phase systems, and maximum switching frequency of 20 kHz.
6. Size and supply reactors to comply with the drive manufacturer's recommendation.
7. Coordinate drive settings as required for compatibility with input line reactors.

79-16.02J(2)(b) Main Drive Braking Resistors

Provide braking modules and braking resistors sized to provide a braking torque of at least 150 percent rated motor full load torque for a duty cycle consisting of 30 seconds on at 150 percent, then four and one-half minutes off, or to comply with the drive manufacturer's recommendation.

Use braking modules of the same manufacturer as the VFD and designed for use with the VFD, including all inputs and outputs required for proper interfacing with the VFD. Include module overload with converter protective features.

Braking resistors must be edge-wound stainless steel, mounted in ventilated enclosures. Openings must be screened or otherwise protected to prevent entry of small rodents. Use stainless steel or similarly corrosion resistant hardware. Wire braking resistors to terminal blocks with high temperature silicone or Teflon wire rated for 150 degrees Celsius or higher. Interconnect braking module fault contact and resistor built-in over-temperature sensor to the VFD to initiate an alarm and drive stop in the event of a resistor over-temperature condition.

79-16.02K Labels and Identification

Provide one piece engraved plastic type legend plates for indicator lights, selector switches, pushbuttons, and exterior cabinet and enclosure labels with black text on a white background. Fasten exterior cabinet labels with stainless steel machine screws. Use of adhesive back labels is permitted for labels mounted inside cabinets and enclosures.

79-16.02L Laptop Computer

Provide a laptop computer as shown on the Plans. Configure laptop with all control system software and applications including PLC, drive, and boat detection applications. License all software to the Owner.

79-16.02M Spare Parts

Provide the following spare parts:

1. One (1) variable frequency drive (pre-programmed), including braking resistor(s) and input and output line reactor(s)
2. One (1) disconnect switch of each type used.
3. Two (2) of each type of surge protective device used.
4. One (1) PLC processor.
5. Two (2) of each type of PLC module used.
6. Two (2) of each type of limit switch used.
7. One (1) rotary cam limit switch with resolver.
8. One (1) inclinometer.
9. Ten (10) maintenance lighting fixtures of each type.
10. Four (4) of each type of relay and other control devices used.
11. Three (3) of each size and type of fuse used.
12. Six (6) of each pushbutton, key/selector switch, and indicator light used.
13. One (1) complete pier navigation light assembly.
14. One (1) complete lift span navigation light assembly.

79-16.03 CONSTRUCTION**79-16.03A General Construction**

Provide all miscellaneous products, tools, equipment, and labor necessary to complete all work.

Install all machinery components by certified millwrights experienced in precision machinery alignment.

Install all products to comply with their manufacturers' recommendations and the NEC.

Coordinate with the United States Coast guard (USCG), the United States Corps of Engineer (USCE), the local Department of Environmental Protection, and other local agencies, and acquire permits and/or permission for the Work performed in and/or over the navigable waterways. Obtain explicit permission and/or permit from the USCG for any bridge closure or delay of the marine traffic. Notify the USCG of any change to the work schedule.

Spillage of oil and hazardous material is prohibited. Properly maintain construction equipment, and carefully and properly handle fuel and hazardous material so as not to cause any spillage in the waterway. Instruct personnel not to dispose of oil/hazardous material into the waterway directly or indirectly and have plans to remove any spillage of such materials, should it occur. The removal method must be as authorized by the State and Federal laws and regulations.

79-16.03B Installation

Prior to commencing installation verify that all surfaces upon or in which equipment and devices are to be mounted, are properly prepared.

Before mounting of enclosures, complete all wire pulling and tag all wires.

79-16.03C Operation and Maintenance of Bridge During Construction

Operate the bridge any time that a bridge operation is required from the time the lift span is in place until all required testing and training is complete, the construction of the bridge is complete, and final acceptance of the project has been issued. During this time, maintain the lift span. Maintain and provide any required

adjustments and corrections to all work during construction and until all required training and the period of Contractor supervised operation is complete.

At all times, provide at least one operator available to operate the bridge during this construction phase. Maintenance of the lift span includes performing all required machinery lubrication and any adjustments or corrections required to maintain the bridge operational.

Always provide at least one "on-call" individual available while Contractor personnel are not working on-site. This individual must be available and able to resolve any issues that are a result of work performed on-site.

Follow OSHA lockout/tagout procedures. Coordinate lockout of the bridge operating machinery with bridge operations.

79-16.03D Wiring

Use conductors with green colored insulation only for grounding conductors. The re-identification of conductors with green colored insulation, such as with colored tape, is prohibited.

Supply a dedicated neutral conductor for all branch and feeder circuits requiring a neutral. Do not share a dedicated neutral conductor by phase conductors of other circuits.

Provide equipment grounding conductors in all conduit and cable runs. Unless otherwise noted, size equipment grounding conductors equal to the largest circuit conductor in the conduit or cable. Coordinate all wire and cable requirements with manufacturers of the equipment served.

Handle and install wires and cables with care to avoid damage to conductors, insulation, jackets, armor, etc. Replace any wire or cable which is found to be damaged.

Permanently label all conductors, cables, and terminal blocks at every terminal or connection, splice, and tap. Assign each conductor or cable with one identifying number (including spares) throughout the entire electrical and control system. Coordinate identification numbers for consistency and accuracy with conductor numbers on the wiring diagrams and shop drawings, field wiring diagrams, and any other diagrams containing the same corresponding conductor or cable.

Label all conductors with machine printed self-sealing, adhesive-type labels. Use water and smudge resistant text. Coordinate label text with wiring diagrams and shop drawings. Handwritten labels are prohibited.

79-16.03E Conduit and Cable

Unless otherwise noted, install connections of conduit and cable entrances only in the bottom of cabinets and enclosures which are located outdoors and in damp locations.

Maintain at least a 4-inch separation between power wiring and communication and/or instrumentation cables.

Use weatherproof cable(s) only where the final connection to equipment requires the use of a cable and final connection via conduit or flexible conduit is not feasible. Use cable connectors where weatherproof cable(s) transition from conduit and where weatherproof cable(s) enter box(es) or enclosure(s).

Provide insulated throat bonding bushings or bonding nuts where conduits or metal armored cables enter metal boxes or enclosures. Properly bond/ground conduit to the bonding/grounding hub. Connect bonding bushings and bonding nuts to the equipment grounding conductor included in the conduit or cable.

Install metal conduit and tubing in accordance with the *Steel Tube Institute of North America's Guidelines for Installing steel conduit/tubing*.

Make bends in rigid conduit with tools designed for bending the type and size of conduit in question. When bending conduit maintain proper internal diameter and wall thickness.

Do not make more than three quarter bends, equivalent to 270 degrees, in one conduit run between pull points such as conduit bodies, junction/pull boxes, terminal cabinets, and enclosures.

Make field cuts square to conduit and ream conduit ends to remove burrs. Field cut threads must have same length, dimensions, and taper as factory-cut threads. Clean field cut threads with an appropriate degreasing solvent after cutting and coat with a touch-up compound as recommended by the conduit manufacturer and a urethane topcoat. Similarly treat any area on the interior of the conduit which has been disturbed by reaming.

Install PVC coated rigid metal conduit using tools and methods which will not cause damage to the PVC coating, and to comply with installation instructions provided by the conduit manufacturer. Coat any area on the exterior of the conduit which has been damaged during installation with an exterior patching compound as recommended by the conduit manufacturer.

Repair, by replacing the entire section of conduit, any defect (nick, scar, cut, tear, abrasion) to the PVC coating of PVC coated rigid metal conduit that is 3 inches or more in length. Repair any defect to the PVC coating which is less than 3 inches long with an appropriate repair compound as recommended by the conduit manufacturer. Submit proposed conduit repair details for approval.

Support rigid conduits near each elbow and within 18 inches of each box, enclosure, conduit body, or similar termination, and at regular intervals not to exceed 6 feet.

Support flexible conduits near each elbow and within 12 inches of each box, enclosure, conduit body, or similar termination, and at regular intervals not to exceed 3 feet, except where flexibility is required.

Provide conduit penetrations through walls, floors, and ceilings as necessary for the installation of conduits. Following the installation, restore floors, walls and ceilings with materials equal to the original construction and finish to match surrounding surfaces.

79-16.03F Wire and Cable Pulling

Thoroughly swab raceway system before installing conductors. Use pulling lubricant to facilitate installation of wire and/or cable in conduits. Use lubricant that is NRTL listed, environmentally friendly, Teflon based and safe for use with all cable types and does not harden in conduit.

Replace conductors and cables, which are damaged during shipping, handling, storage or during the installation, or due to high pulling tension during the installation as revealed during any inspection or tests.

79-16.03G Low Voltage Splices, Terminals, and Terminal Blocks

Splice and tap conductors only in equipment enclosures, cabinets, or junction boxes, and on terminal blocks or with insulated compression crimping-type connectors. Do not terminate more than two conductors per terminal block. Make splices and taps at equipment or in locations which do not permit the use of terminal blocks with crimp or mechanical type connectors when permitted.

Make connections to motor terminal leads only with means which will allow for disconnection without cutting motor leads, such as two crimp type lugs bolted together or mechanical type connectors.

The use of wire nut connectors is prohibited.

Insulate all splices made with crimp or mechanical type connectors with rubber and vinyl tape, or an insulating cover specifically designed for use with the connector. Use special splices or splice kits to address specific application considerations.

For splices without integral insulating sleeves, tightly apply a minimum of one half-lapped layer of rubber tape, tacky side up, over entire splice and extending onto the conductor insulation at least one tape width on both sides of splice. Apply a minimum of two half-lapped layers of vinyl tape completely over rubber tape and extending onto conductor insulation past ends of rubber tape.

For splices which are provided with integral insulating sleeves, apply a minimum of two half-lapped layers of vinyl tape completely over splice and extending onto conductor insulation, past ends of splice.

79-16.03H Grounding and Bonding

Provide grounding and bonding to comply with NEC Article 250 for grounding and bonding.

Do not use raceways and metallic cable armor/sheaths as the sole grounding or bonding conductor for any circuit.

Solidly connect all electrical equipment to the equipment grounding conductor serving that equipment.

Bond the ground buses of all equipment to the nearest substantial structural steel member. Size bonding jumpers equal to the equipment grounding conductors serving the equipment. Install the bonding jumper to

comply with the NEC for grounding electrode conductors. Use bare ground wire when installing a bonding wire in junction boxes, terminal cabinets, and enclosures.

Where bolted connections are used for connection of equipment grounding conductors to equipment, clean the area around the connection down to bare metal prior to making the connection. Touch-up the area with paint after the connection is made to comply with the equipment manufacturer recommendations.

79-16.03I Equipment Cabinets and Enclosures

Where equipment cabinet or enclosure sizes are specified, this indicates the minimum size required. Upsize the box or enclosure to comply with the NEC and manufacturer recommendations.

79-16.03J Mounting Brackets

Fabricate mounting brackets for the specific equipment and devices to accommodate the specific mounting locations and equipment. Submit shop drawings and details of mounting brackets proposed for installation with indicated dimensions, materials, type, and materials of anchorage.

79-16.03K Touch-up Painting

Touch-up paint all scratches and damage to factory-applied finishes on electrical equipment and enclosures, raceways, and boxes to repair the damage to the factory finish. Use touch-up painting at least one coat of primer, and two coats of finish paint. Use primer and paint as supplied or recommended by the manufacturer of the item being painted.

79-16.03L CCTV System

Install CCTV system in accordance with the manufacturer's instructions. Aim, adjust, align, focus, and perform all necessary system set-ups to achieve required viewing image performance. Mount and aim each camera to achieve the optimal field of view. Coordinate final camera field of views with the Owner.

Use water-tight fittings for connection to cameras. Do not permanently install cameras until major construction activities on the bridge have been completed. Provide means of protection from damage and debris for installed cameras while construction is still underway.

79-16.03M Main Drive System

The CSV must perform the manufacturer recommended sequence for tuning the main drive (variable frequency drive) to the main drive motor. Adjust any other main drive settings necessary to ensure fully functional and reliable bridge operations.

See the Special Provisions for Bridge Machinery Common Provisions and Bridge Operating Machinery for additional construction requirements and hardware required for the installation of the main drive motors.

79-16.03N PLC Programming

Ladder logic shown on the Plans is conceptual only. Provide additional logic development and program writing necessary for complete programs suitable for operating the bridge. Use ladder logic type programming language/format.

Provide descriptive address names/tags for all used and reserved addresses for input and output points and internal memory locations. Use line comments to provide additional explanations for complex logic, calculations/scaling and to identify sections of logic for specific purposes.

Provide PLC function(s) to allow drive faulted conditions to be reset from the SCADA System main drive configuration screen. Password protect user ability to acknowledge, reset, and clear drive faults.

79-16.03O SCADA (Supervisory Control and Data Acquisition) System

Provide a web-based SCADA system with a graphical user interface (GUI) for remote monitoring as described herein. Configure the SCADA system with the following features and characteristics:

1. SCADA system shall provide the ability to monitor/view the CCTV camera and PLC system, through a web-based software, protected through a Virtual Private Network (VPN). The VPN shall provide secure web-based access to the PLC and CCTV system and meet the requirements as listed under section 79-16.02G(11) VPN Router.

2. The SCADA system shall provide the user with the ability to replicate all data that could be accessed locally at the bridge.
3. Provide the viewer with real time and historical data through the GUI, as listed below, for the CCTV and PLC system.
4. Provide multi-user and multi-workstation capability without operator restrictions other than password and access rights.
5. Provide standard interfaces to monitor and control a variety of SCADA field equipment from a variety of manufacturers.
6. Provide industry standard protocols to support communications with PLC's and other facilities management devices.
7. The systems integrator shall provide the Owner with a non-exclusive, perpetual, irrevocable, royalty-free license to use the SCADA software and related third-part software. This software shall contain no license key or other mechanisms preventing the user from expanding or utilizing the software to its fully licensed capabilities, nor allow for additions of workstations, SCADA control devices, graphics, reports, etc. To protect the Owner against lack of future support, all source code for the core of SCADA software owned by the vendor shall be provided to the customer under the terms of confidentiality agreement.

79-16.03O(1) Graphical User Interface (GUI)

Configure the GUI with the following graphic screens, features, and characteristics:

1. Configure the GUI to automatically default to display the main bridge overview screen upon startup. Utilize a simple menu type system to organize graphic screens and to allow the user to quickly navigate between screens.
2. Main Bridge Overview Screen. On the main bridge overview screen, provide a simplified graphical representation of the bridge with position/height status, skew monitoring status, boat detection status, status of brakes, span locks, and gates/bollards, main drive(s) speed and direction, automatic transfer switch status, and links to all configured screens.
3. Bridge Control Console Screen. On the bridge control console screen, mimic the control console layout local to the bridge. Include height status and main drive(s) speed on this screen and configure graphical indicator lights to appear grey when not on and to change color to the respective indicator light color when on. Mimic the appearance and operation of the selector switches and pushbuttons. Password protect user access to this screen.
4. Main Drive Status Screen. On this screen, mimic the main drive cabinet(s) HMI panel display and show, at a minimum, drive speed, torque, current, and frequency for each drive. Configure the drive HMI panel graphic to display a real-time pop-up if an error or fault occurs at the drive. Provide a link with the pop-up to navigate the user to the fault/alarm history screen.
5. Fault/Alarm History Screen. Configure this screen to keep a complete history of bridge PLC and main drive faults and alarms. Provide date/time stamps for each fault and alarm to show the date and time it was activated, acknowledged, and cleared. Password protect user ability to acknowledge and clear faults and alarms. List the fault/alarm history in chronological order with the most recent item listed first. Color code each item to distinguish between active unacknowledged (flashing red), active acknowledged (solid red), and cleared faults and alarms. Provide option to sort faults and alarms by status, date, or alphabetically. For each possible PLC and drive fault/alarm, pre-configure in the program the name of the fault/alarm, a brief description, and a recommended action for the user (i.e. contact maintenance). Configure the program to display these when a fault/alarm is active. Provide a password protected link for each fault/alarm item to navigate the user to a diagnostic/troubleshooting screen.
6. Diagnostic/Troubleshooting Screen(s). Configure a password protected screen (linked from the fault/alarm history screen) for each possible fault/alarm to display a recommended action for diagnosing and troubleshooting the fault/alarm. Provide options for the user to acknowledge and clear the fault/alarm on this screen.
7. CCTV Camera Screen(s). Configure a main CCTV camera screen to show all camera views on one screen. Configure each camera view to enlarge to a full screen single camera view when selected. Include additional links on this screen to navigate to other preconfigured camera group screen(s). Each camera group screen will show larger views of one or multiple cameras as requested by the Owner. Coordinate with the Owner for desired group camera screen(s).
8. Configure all screens to display a new fault/alarm, with description and recommended action for the bridge operator, with link to navigate the user to the fault/alarm history screen.
9. Configure all screens with links to navigate back to the previous screen and the main bridge overview screen.

10. Coordinate with the Owner and the Engineer and provide other screens and features as requested and for setup of all password protected user access and abilities.

79-16.03O(2) Control Console Human Machine Interface (HMI)

Configure the control console human machine interface (HMI) with the following graphic screens, features, and characteristics:

1. Configure the GUI to automatically default to display the main bridge overview screen upon startup. Utilize a simple menu type system to organize graphic screens and to allow the user to quickly navigate between screens.
2. Main Bridge Overview Screen. On the main bridge overview screen, provide a simplified graphical representation of the bridge with position/height status, skew monitoring status, boat detection status, status of brakes, span locks, and gates/bollards, main drive(s) speed and direction, automatic transfer switch status, and links to all configured screens.
3. Main Drive Status Screen. On this screen, mimic the main drive cabinet(s) HMI panel display and show, at a minimum, drive speed, torque, current, and frequency for each drive. Configure the drive HMI panel graphic to display a real-time pop-up if an error or fault occurs at the drive. Provide a link with the pop-up to navigate the user to the fault/alarm history screen.
4. Fault/Alarm History Screen. Configure this screen to keep a complete history of bridge PLC and main drive faults and alarms. Provide date/time stamps for each fault and alarm to show the date and time it was activated, acknowledged, and cleared. Password protect user ability to acknowledge and clear faults and alarms. List the fault/alarm history in chronological order with the most recent item listed first. Color code each item to distinguish between active unacknowledged (flashing red), active acknowledged (solid red), and cleared faults and alarms. Provide option to sort faults and alarms by status, date, or alphabetically. For each possible PLC and drive fault/alarm, pre-configure in the program the name of the fault/alarm, a brief description, and a recommended action for the user (i.e. contact maintenance). Configure the program to display these when a fault/alarm is active. Provide a password protected link for each fault/alarm item to navigate the user to a diagnostic/troubleshooting screen.
5. Diagnostic/Troubleshooting Screen(s). Configure a password protected screen (linked from the fault/alarm history screen) for each possible fault/alarm to display a recommended action for diagnosing and troubleshooting the fault/alarm. Provide options for the user to acknowledge and clear the fault/alarm on this screen.
6. Configure all screens to display a new fault/alarm, with description and recommended action for the bridge operator, with link to navigate the user to the fault/alarm history screen.
7. Configure all screens with links to navigate back to the previous screen and the main bridge overview screen.
8. Coordinate with the Owner and the Engineer and provide other screens and features as requested and for setup of all password protected user access and abilities.

79-16.03O(3) Machinery Rooms Human Machine Interface (HMI)

Configure the machinery rooms human machine interface (HMI) with the following graphic screens, features, and characteristics:

1. Configure the GUI to automatically default to display the main bridge overview screen upon startup. Utilize a simple menu type system to organize graphic screens and to allow the user to quickly navigate between screens.
2. Main Bridge Overview Screen. On the main bridge overview screen, provide a simplified graphical representation of the bridge with position/height status, skew monitoring status, boat detection status, status of brakes, span locks, and gates/bollards, main drive(s) speed and direction, automatic transfer switch status, and links to all configured screens.
3. Bridge Control Console Screen. On the bridge control console screen, mimic the control console layout local to the bridge. Include height status and main drive(s) speed on this screen and configure graphical indicator lights to appear grey when not on and to change color to the respective indicator light color when on. Mimic the appearance and operation of the selector switches and pushbuttons. Password protect user access to this screen.
4. Fault/Alarm History Screen. Configure this screen to keep a complete history of bridge PLC and main drive faults and alarms. Provide date/time stamps for each fault and alarm to show the date and time it was activated, acknowledged, and cleared. Password protect user ability to acknowledge and clear faults and alarms. List the fault/alarm history in chronological order with the most recent item listed first. Color code each item to distinguish between active unacknowledged (flashing red), active acknowledged (solid red),

and cleared faults and alarms. Provide option to sort faults and alarms by status, date, or alphabetically. For each possible PLC and drive fault/alarm, pre-configure in the program the name of the fault/alarm, a brief description, and a recommended action for the user (i.e. contact maintenance). Configure the program to display these when a fault/alarm is active. Provide a password protected link for each fault/alarm item to navigate the user to a diagnostic/troubleshooting screen.

5. Diagnostic/Troubleshooting Screen(s). Configure a password protected screen (linked from the fault/alarm history screen) for each possible fault/alarm to display a recommended action for diagnosing and troubleshooting the fault/alarm. Provide options for the user to acknowledge and clear the fault/alarm on this screen.
6. CCTV Camera Screen(s). Configure a main CCTV camera screen to show all camera views on one screen. Configure each camera view to enlarge to a full screen single camera view when selected. Include additional links on this screen to navigate to other preconfigured camera group screen(s). Each camera group screen will show larger views of one or multiple cameras as requested by the Railroad. Coordinate with the Owner for desired group camera screen(s).
7. Configure all screens to display a new fault/alarm, with description and recommended action for the bridge operator, with link to navigate the user to the fault/alarm history screen.
8. Configure all screens with links to navigate back to the previous screen and the main bridge overview screen.
9. Coordinate with the Owner and the Engineer and provide other screens and features as requested and for setup of all password protected user access and abilities.

79-16.03P Electrical Testing and Measurements

79-16.03P(1) General

Perform all testing, inspections, and any resulting corrective work to ensure that, after the installation of the electrical materials and equipment for the required work, the entire bridge power and control systems function properly.

In addition to the specific tests described herein, perform all additional testing, and make any necessary repairs or adjustments to provide a complete, functional, and reliable installation.

Use test procedures and equipment to comply with manufacturer's recommendations, *NETA Acceptance Testing Standards*, any other applicable industry standards, and appropriate for the specific test being performed.

Use true root mean square (RMS) type voltmeters and ammeters. Maintain in proper calibrated condition and use all tools and instruments specifically designed for measuring the quantity in question.

79-16.03P(2) Submittals

Submit proposed testing procedures, including test instruments, up-to-date instrument calibration proof, and other equipment to be used for approval at least 15 working days prior to testing.

Accurately record the results of all tests in a neat and orderly manner along with time and date of test(s), environmental conditions (temperature, humidity, general weather conditions, etc.), testing equipment used, conditions of test(s), and the name(s) of person(s) performing the test(s).

Submit all test results with all text in typewritten format no later than 10 working days from date of test(s). The results of these tests must be deemed acceptable prior to acceptance of the work in question.

Submit insulation resistance testing of the main drive motor(s) at the time of installation and at final acceptance.

Submit insulation resistance testing of all power and control conductors (including chain cable carrier conductors), except for instrumentation conductors.

Submit results of operational testing after installation. Operational testing must include three-phase motor current measurements for at least one complete bridge operation (raise and lower) for each main drive motor.

79-16.03P(3) Shop Test

Perform a shop test for the control system prior to shipment from the CSV's shop. Ensure the shop test is witnessed by the Engineer or the Engineer's designated representative. Include a complete run through of the operating sequence and confirm all safety interlocking.

Perform a shop test of the drives and motors prior to shipment from the shop. Ensure that each motor is tuned to its associated drive and coordinate the motor and drive shop test with the shop testing required by BRIDGE MACHINERY COMMON PROVISIONS and BRIDGE OPERATING MACHINERY.

Prepare a detailed testing procedure for shop testing of the installed work. Submit the shop test procedure at least 3 weeks in advance for approval before beginning shop testing. Coordinate with the Owner and schedule the test at a time agreeable to all parties involved. Determine the schedule at least 2 full weeks in advance of the proposed start date for the testing. If an approved shop testing procedure is not documented prior to the scheduled time of the test, the Owner retains the right to reschedule the test.

Note that not all components will be present at the shop test; use simulation of these components to perform the most complete shop test as practical. Utilize temporary indicator lights and control switches as required. Demonstrate the user screens and operation of the GUI during the shop test.

Wire and assemble all PLCs, relays, and other related control system components to the extent practical in the proper cabinet(s) and make ready for shipping pending any corrections or adjustments necessitated by testing results, before performing such tests.

Correct any errors found in the system and rerun the respective portion of the test.

79-16.03P(4) Testing and Inspection after Installation

After all wires have been installed and prior to connections of any circuit, test to verify that all installed conductors are free of shorts, opens, or unintentional grounds, and properly terminated.

Measure and record the insulation resistance of the new main drive motor. Make measurements at the motor, or at the local disconnect switch. Measure and record the insulation resistance of all newly installed power and control conductors, except for instrumentation conductors. The minimum acceptable resistance is 100 megohms (at 500V DC).

Measure the contact resistance of all new circuit breakers and contactors. Deviation of 50 percent or more between contacts of any device, or between contacts of similar devices, is considered a failure.

Perform tests after energizing any circuit and prior to connections to equipment or motors to verify the following conditions:

9. Correct no-load voltage for the equipment to be powered.
10. Correct phase sequence.
11. Correct polarities.

After all connections have been made to all equipment and devices, visually inspect all electrical connections, and verify that all lugs, connectors, and terminals are tightened and torqued to the levels recommended by the manufacturer.

79-16.03P(5) Testing of Motors and Machinery

Prior to first operation of any motor or motor driven machinery, confirm proper motor rotation with all driven machinery disconnected or otherwise suitably arranged to prevent damage in the event of incorrect rotation. After confirming proper rotation, record the correct circuit phase to motor terminal connections on the as-built plans and working drawings.

Visually inspect all motors and motor driven machinery, including, but not being limited to, checking for excess mechanical or electrical noise, for excessive heating, for vibration, verifying proper tightening of all mounting bolts and coupling connections, and observation of any other physical indications of improper installation and operation.

Following final acceptance, measure and record the motor terminal voltage and three-phase currents for the main drive motor through one complete bridge operation (raise and lower). Take measurements at the outputs of the VFD and continuously record with suitable computer-based recording equipment at a data sampling rate of at least 20 samples per second.

79-16.03P(6) Operational Tests and Demonstrations

Prior to attempting to test-run the bridge, test and verify that all PLC input/output wiring has been installed correctly. Verify the correct operation of all limit switches and sensors.

When the installation of all systems is complete and ready for testing, test-run the lift span. Demonstrate a trouble-free bridge operation, meeting all specified requirements with all interlocks properly functioning through the PLC control system.

Perform additional miscellaneous operational tests to demonstrate and establish that the work as installed meets all specified requirements and is operating in a reliable manner.

79-16.03P(7) Final Field Acceptance Testing

Perform a final field acceptance test for the bridge operation, control system, and other components as described herein after all required components are installed and initial operational tests and demonstrations are complete. Ensure the final field acceptance test is witnessed by the Engineer or the Engineer's designated representative. The final field acceptance test must include the following demonstrations:

1. Include a complete run through of the operating sequence for the normal operation mode. A minimum of 10 consecutive, successful, error free, and full bridge operations are required, including at least 2 bridge operations with each possible drive motor combination. Perform at least 2 successful bridge operations utilizing generator power. Perform at list one successful operation in manual operation mode. Perform all bridge operations within one single day. In the case of any error or required adjustment, restart the count of successful operations.
2. Verify that the bridge automatically raises per the specified boat detection sequence when a boat is detected underneath the lift span (boat detection may be simulated if necessary).
3. Verify that all lift span devices operate successfully when operated manually with the local motor control center switches.
4. Verify the successful operation of the manual span leveling mode.
5. Verify that the lift span can be successfully raised and lowered locally from the drive cabinets without PLC control. Extra caution and supervisory personnel will be required to successfully raise and lower the lift span in this manner. A formal procedure must be developed and approved prior to performing this operation.
6. Perform one complete check of proper bridge safety interlocking.
7. Confirm with the Owner the final field of view and presets of all CCTV cameras and the arrangement of the camera views on the wall mount monitors.
8. Demonstrate that all bridge lighting, navigation lighting, automatic transfer switch and backup generator, and other miscellaneous systems are operating satisfactorily.
9. Perform additional tests and demonstrations to demonstrate that the installed systems satisfy the requirements.

Prepare a detailed testing procedure for final field acceptance testing of the installed work. Submit the final field acceptance test procedure at least 3 weeks in advance for approval before beginning final field acceptance testing. Coordinate with the Owner and schedule the test at a time agreeable to all parties involved. Determine the schedule at least 2 full weeks in advance of the proposed start date for the testing. If an approved final field acceptance testing procedure is not documented prior to the scheduled time of the test, the Owner retains the right to reschedule the test. In the event a reschedule is required, the Contractor will bear any costs associated with delay and rescheduling of travel arrangements.

Correct any deficiencies revealed during testing and repeat the test following the correction of deficiencies.

For final acceptance by the Owner, the minimum 10 consecutive bridge operations must be successful and error-free, and operation and maintenance training must be completed.

79-16.03P(8) Operation and Maintenance Training

After all systems are installed and tested, the bridge and its control and drive systems are proven to operate reliably, and the 10 bridge operations, as described above are successful, provide operation and maintenance training for maintenance personnel. Provide training for a minimum of three full 8-hour working day, with a minimum of 1 week notice to the Owner. Training must include the following:

1. Using and navigating the GUI and HMI interface(s), including viewing drive and bridge status, and interpreting common VFD and PLC errors and faults and respective corrective actions.
2. Overview of PLC equipment, including basic troubleshooting and recommended maintenance.
3. Overview of CCTV system, including basic operation and navigation of the NVR, switching between preloaded camera views, and basic troubleshooting and recommended maintenance.
4. Overview of bridge operating sequence and interlocking.

5. [Basic newly installed device troubleshooting instructions.](#)
6. [Include additional training at the request of the Owner.](#)

79-16.03Q Corrective Actions

[For any test failure, or for any test result which fails to meet the specified requirements or the stated acceptable values or conditions, investigate the cause of the failure, take appropriate corrective actions, and repeat the test\(s\). Repeat this procedure until such time as all test results are deemed acceptable.](#)

79-16.03R Contractor Supervised Lift Span Operation

[Provide a minimum of one person to supervise the operation of the bridge for a period of 7 calendar days after final acceptance by the Owner \(after final field acceptance testing and operation and maintenance training is complete\) and provide one person on call for an additional 7-day period. Ensure these people can operate the bridge, to supervise its operation, and to make any adjustments or corrections that may be required in the electrical, PLC, and control equipment of the bridge. They must instruct and qualify the Owner employees in the operation of the bridge. Any adjustments or corrections required during the two 7-day periods must be at no additional cost.](#)

79-16.04 PAYMENT

[Payment for the movable bridge electrical and control system is full compensation for furnishing, testing, and installing the movable bridge electrical and control system as a lump sum. No method of measurement.](#)

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DIVISION IX TRAFFIC CONTROL DEVICES

83 RAILINGS AND BARRIERS

Add to the end of section 83-2.05B(3):

[Steel plates, posts, and HSS sections are subject to AESS category 3 for visible surfaces.](#)

Add to section 83-2.05B:

83-2.05B(5) Architectural Elements:

[Black Locust Hardwood must comply with section 83-2.10.](#)

[Stainless steel end caps must comply with ASTM A240 type 304.](#)

[Perforated steel sheets must comply with ASTM A653 and are subject to AESS category 3 for visible surfaces.](#)

Add to section 83-2.05D:

[The Payment quantity for California Bridge rail includes the architectural elements.](#)

Add to section 83-2.05B(4):

[Prepare and paint the exposed galvanized surfaces of the California bridge rail under section 59-3.](#)

[Do not chemically treat the galvanized surfaces before cleaning and painting. Galvanize the nuts, bolts, and washers after fabrication.](#)

Add to the end of section 83-2.08A(1):

[Where shown, paint for railing must comply with section 59-3.](#)

Add to the end of section 83-2.08B:

[All tubular railing components are subject to AESS category 3 for visible surfaces.](#)

Add to section 83-3.02:**84-3.02I Bridge Number Plaque:**

Stainless steel for the Bridge Number Plaque must comply with ASTM A240/A240M, Type 316.

Add to section 83-3.04:

The Payment for Concrete Barrier Type 85 includes the Bridge Number Plaque.

Replace section 83-2.10 with:**83-2.10 PEDESTRIAN RAILING****83-2.10A General****83-2.10A(1) Summary**

Section 83-2.10 includes specifications for constructing pedestrian railings and Type B luminaire lighting supports.

83-2.10A(2) Definitions

NHLA: National Hardwood Lumber Association

83-2.10A(3) Submittals**83-2.10A(3)(a) General**

Not Used

83-2.10A(3)(b) Shop Drawings

Submit shop drawings for the pedestrian railing and Type B luminaire lighting supports. Shop drawings must include:

1. Pedestrian railing and associated components
2. Type B luminaire lighting supports
3. Complete details for the construction of work, including construction methods, sequence of shop and field assembly, and installation sequence and procedures for the pedestrian railing and type B luminaire lighting supports

Submit 7 copies of the shop drawings. Allow 25 days for review. Upon authorization, the Engineer returns 2 copies to you for use during construction.

83-2.01A(3)(c) Certificate of Compliance

Submit a certificate of compliance signed by the supplier's QC representative for the pedestrian railing for each shipment.

Submit an American Tree Farm System (AFTS) or Programme for Endorsement of Forest Certification (PEFC) certification for black locust hardwood.

83-2.10A(4) Quality Assurance

Not Used

83-2.10B Materials**83-2.10B(1) General**

Not Used

83-2.10B(2) Metal Components

Stainless steel plates must comply with ASTM A240/A240M, Type 316.

Stainless steel end caps must comply with ASTM A240 type 304.

Stainless steel rope mesh must comply with ASTM A492, Type 316.

Stainless steel pipe must comply with ASTM A312 Type 316.

Stainless steel bolts must comply with ASTM A193 Grade B8M. Stainless steel nuts must comply with ASTM A194, Grade 8M. Stainless steel washers must conform to ASTM A666 Type 316.

Stainless steel fasteners must comply with section 75-1.02.

All stainless steel must receive a 4b brushed finish and be subject to AESS category 3 for visible surfaces.

Type B luminaire lighting supports are subject to AESS category 3 for visible surfaces.

Structural shapes, plates, bars, bolts and studs must comply with section 55-1.02. Other fittings must be commercial quality.

Railings must conform to the curvature by means of a series of short chords, from center-to-center of rail posts, except (1) tubing for railings described as conforming to the curvature must be shop bent to fit the curvature and (2) tubing with a horizontal curve radius less than 900 feet must be shop bent or fabricated to fit the curvature. Joints must be matchmarked.

83-2.10B(3) Wood Components

Black Locust Hardwood (Robinia Pseudocacaia) must be NHLA FAS grade and comply with the requirements shown in the following table:

Black Locust Hardwood Material Properties

<u>Material Property</u>	<u>Specification</u>
<u>Average Dried Weight</u>	<u>48.0 pcf</u>
<u>Specific Gravity (basic 12% moisture content)</u>	<u>0.66, 0.77</u>
<u>Jacka Hardness</u>	<u>Log of Test Borings</u>
<u>Modulus of Rupture</u>	<u>19,400 psi</u>
<u>Elastic Modulus</u>	<u>2,050,000 psi</u>
<u>Crushing Strength</u>	<u>10,200 psi</u>
<u>Shrinkage</u>	<u>Radial: 4.6%, Tangential: 7.2%, Volumetric 10.2% T/R ratio 1.6</u>

Wood screws must comply with section 75-3.

83-2.10B(4) Coatings

Do not chemically treat the galvanized surfaces of the type B luminaire lighting supports before cleaning and painting. Galvanize the nuts, bolts, and washers after fabrication under section 75-1.02B.

Apply a pure Tung Oil (China wood oil) with no drying additives to the black locust hardwood rub rail per manufacturer's specifications.

83-2.10C Construction

Construction of pedestrian railing must comply with 83-2.05C.

Welding of steel members must comply with AWS D1.1.

Welding of stainless steel members must comply with AWS D1.6.

Prepare and paint the exposed galvanized surfaces of the type B luminaire lighting supports under section 59-3.

Black Locus hardwood must be stored in a protected area. Protect the Black Locus Hardwood from the sun to prevent warping.

Black Locus hardwood must sit for 7 days prior to installation to allow the wood to acclimatize to the local temperature and humidity levels.

83-2.10D Payment

Not Used

Replace section 83-2.11 with:**83-2.11 PEDESTRIAN BRIDGE RAILING****83-2.11A General****83-2.11A(1) Summary**

Section 83-2.11 includes furnishing and installing the pedestrian bridge railings.

83-2.11A(2) Definitions

NHLA: National Hardwood Lumber Association

83-2.11A(3) Submittals**83-2.11A(3)(a) General**

Not Used

83-2.11A(3)(b) Shop Drawings

Submit shop drawings for pedestrian bridge railing. Shop drawings must include:

1. Details for venting holes in rails, posts, and sleeves
2. Railing layout
3. Manufacturer's product literature for fasteners and cable, including warranties
4. Complete details for the construction of the work, including construction methods, sequence of shop and field assembly, and installation procedures.

Submit seven (7) copies of the shop drawings. Allow a minimum of twenty-five (25) days for review of the shop drawings. Upon authorization, the Engineer returns two (2) copies during construction.

83-2.11A(3)(c) Certificate of Compliance

Submit a certificate of compliance signed by the supplier's QC representative for the pedestrian bridge railing for each shipment.

83-2.11A(4) Quality Assurance**83-2.11A(4)(a) General**

Not Used

83-2.11A(4)(b) Warranties

Provide a minimum 10-year manufacturer's warranty for the isolation bushings.

83-2.11A(4)(c) Quality Control

Not Used

83-2.11B Materials**83-2.11B(1) General**

Not Used

83-2.11B(2) Metal Components

Structural shapes, structural tubing, plates, bars, bolts, nuts, and washers must comply with section 55-1.02 unless noted otherwise. Other fittings must be commercial quality.

Provide pipe railing conforming to ASTM A500/A500M, Gr. C.

Formed steel sections must be uniform in appearance.

Galvanize ferrous metal parts in accordance with section 75-1.02B.

Joints must be matchmarked.

Bend pipe in shop. Do not bend pipe in the field.

83-2.11B(3) Cable Baluster

Provide cable conforming to the plans.

Provide cable fasteners that are Type 316 stainless steel.

Provide isolation bushings that are polymer or nylon and resistant to UV degradation.

83-2.11B(4) Wood Components

Provide wood components conforming to section 83-2.10B(3).

83-2.11B(5) Coatings

Paint galvanized steel according to section 59-3.

Organic zinc-rich primer used to paint the exposed bolt threads must be on the Authorized Material List for organic zinc-rich primers.

Apply a wood oil finish to the wood components in accordance with section 83-2.10B(4).

83-2.11C Construction

Construct pedestrian bridge railing in accordance with section 83-2.05C, except as modified herein or on the plans.

Before pedestrian bridge railing parts are assembled, gently clean the bearing surfaces and surfaces to be in permanent contact.

Carefully handle the materials such that no parts are bent, broken, abraded, or otherwise damaged. Do not use manufacturing, handling, or installation methods that damage or distort the members.

Store black locust hardwood in a protected area. Protect the black locust hardwood from the sun to prevent warping.

Allow black locust hardwood seven days to acclimate to the local temperature and humidity levels before installation.

Use carbide-tipped saw blades and Forstner drill bits when working with black locust hardwood.

Install isolation bushings in accordance with the manufacturer's instructions.

Ensure that stainless steel is not in contact with galvanized steel after installation. If stainless steel does contact galvanized steel, notify the Engineer for direction. Additional isolation in the form of bushings, wraps, washers, or other methods as directed by the Engineer will not receive additional payment.

83-2.11D Payment

Payment will be made at the contract unit price per linear foot of pedestrian bridge railing. Payment includes full compensation for labor, materials, tools, equipment, and incidentals necessary to furnish and install the pedestrian bridge railing as shown on the plans and as described herein.

Payment quantity for pedestrian bridge railing is the length of pedestrian bridge railing installed and inspected, as measured from the outside edge to the outside edge of the pedestrian bridge railing.

84 MARKINGS

Replace section 84-2.02D with:

84-2.02D Methyl Methacrylate

MMA resin shall have the following properties:

<u>Density</u>	<u>8.1±0.35</u>	<u>Lbs/Gal</u>
<u>Tensile</u>	<u>>400PSI</u>	<u>ASTM D638</u>
<u>Elongation</u>	<u>>180%</u>	<u>ASTM D638</u>
<u>Flash Point</u>	<u>>10°C</u>	<u>ASTM D1310</u>

The daytime chromaticity green color coordinates shall be as follows:

<u>1</u>		<u>2</u>		<u>3</u>		<u>4</u>	
<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>
<u>0.230</u>	<u>0.754</u>	<u>0.266</u>	<u>0.500</u>	<u>0.367</u>	<u>0.500</u>	<u>0.444</u>	<u>0.555</u>

The daytime luminance factor (Y) shall be at least 7, but no more than 35.

The nighttime chromaticity green color coordinates shall be as follows:

<u>1</u>		<u>2</u>		<u>3</u>		<u>4</u>	
<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>	<u>x</u>	<u>y</u>
<u>0.230</u>	<u>0.754</u>	<u>0.366</u>	<u>0.540</u>	<u>0.450</u>	<u>0.500</u>	<u>0.479</u>	<u>0.520</u>

Aggregate requirements are:

<u>Hardness</u>	<u>7 (Mohs scale)</u>
<u>Color</u>	<u>Light Neutral</u>
<u>Mesh Size</u>	<u>16-40 Grit</u>

Activator/catalyst used shall be per manufacturer recommendations.

MMA shall have the following performance properties:

<u>Build Thickness</u>	<u>90±10</u>	<u>Mills</u>
<u>VOC</u>	<u><100</u>	<u>Grams/Liter</u>
<u>Skid</u>	<u>>60</u>	<u>ASTM E303</u>
<u>Hardness</u>	<u>50-60</u>	<u>ASTM D2240</u>

Add to section 84-2.03B(3):

Prior to applying the MMA pavement markings, the Contractor shall clean the treatment surface and lip of gutter joints to remove all loose material, silt spots, grease, vegetation, and any other matter, which may adversely affect the adherence of the MMA to the existing concrete or pavement. The Engineer may direct the Contractor to re-clean any areas deemed not suitable to receive MMA. All surface preparation shall be performed in accordance with manufacturer's instructions.

The Contractor shall sweep all treatment areas with a mechanical power broom prior to applying MMA. The Contractor shall clean any areas containing chemical contaminants such as vehicle fluid, using a degreasing solution. The Engineer may require particularly dirty streets to be flushed with water. The Engineer must approve all flushing operations. The Contractor shall be responsible for cleaning sidewalks and driveways soiled by flushing operations.

The Contractor shall remove all traffic striping, markings and raised pavement markers conflicting with the surface treatment as identified in the Plans prior to applying MMA. Pavement striping and markings that are to be left in place, utilities, drainage structures, curb and gutters, adjacent pavement and any other structure within or adjacent to the treatment area shall be masked to protect from application. The Contractor shall remove such masking material as MMA gels, but before it cures.

Removed materials shall become the property of the Contractor disposed of in accordance with legal requirements.

Where the completed MMA is not uniform in color, the area shall be treated to eliminate the color variation at no additional cost to the City. The method of treatment shall be subject to approval by the Engineer and may include removal by micro-milling and replacement with MMA. A double layer of MMA shall not be allowed.

86 GENERAL

The interior of the enclosure must accept cable-in/cable-out circuit breakers. The circuit breakers must be mounted on nonenergized clips and vertically with the up position of the handle being the *ON* position.

Replace section 86-1.02Q(4) with:**86-1.02Q(4) Uninterruptible Power Supply for City of West Sacramento**GENERALSummary

This section includes specifications for constructing the City of West Sacramento Uninterruptible Power Supply.

MATERIALS

1500VA 24VDC Traffic Signal UPS Specifications:

ENCLOSURE SPECIFICATIONS:

Aluminum anodized/anodized paint weatherproof enclosure shall house UPS and batteries. Enclosure shall be TIG welded construction with welding materials specifically designed for the material to be welded. Enclosure shall have fully framed side hinged outer doors with swaged close tolerance sides for flush fit with drip lip and closed cell neoprene flange compressed gaskets. Front door shall incorporate a full-length piano hinge, pad-lockable draw latch (center area on door-latch side), and a pad lockable welded-in place vandal-proof tab, rated at 2000 lbs. There shall be no exposed nut, bolts, screws, rivets or other fasteners on the exterior of the enclosure. Maximum cabinet dimensions 46" H x 20" W x 10.25" D. Weight 300 lbs with batteries. UPS shall be mounted in an interior tilt out housing with 800 lb rated stops. Battery connectors shall be Anderson Connectors with silver plated contacts. Batteries shall be installed in fixed position framed shelves for seismic safety and be readily accessible for maintenance.

Batteries shall be mounted allowing airflow front and back. Enclosure can include two transfer bypass switches, one for UPS bypass the second for auxiliary generator (optional). All switches must be panel mounted on interior dead front panel board. UV resistant plastic laminated nameplates shall identify all controls and major components. A plastic covered wiring diagram will be attached to the inside of the front door. All components shall be factory wired and conform to required NEMA, NEC, and UL standards. A chassis ground point shall be provided. Panel shall be UL 508 Industrial Control Panel rated. Shall be a city approved model prior to bid. Must meet the following specifications.

UPS PANEL MINIMUM FEATURES:

- Typical run time is (6) six to (12) twelve hours full operation, based on the actual load.
- UPS bypass and UPS isolation switch.
- Deadfront safety panel board with all switches and plugs pre-wired with phenolic nameplates.
- All nameplates shall be phenolic engraved type.
- All wire terminating lugs shall be full wrap around type.
- All batteries shall be captive spaced from external captive sides in earthquake proof shelving.
 - Cabinet ventilation shall be by (qty. 2) 4" x 1/4" louvers top and bottom with encapsulated bug screens, cleanable filters and a 100cfm fan to completely exchange air 25 time minimum per minute.
 - All DC terminals and connections shall incorporate safety covers such that the safety covers are in place for every normal maintenance mode.
- Event Counters & Total Run Time Counter.

UPS UNIT MINIMUM SPECIFICATIONS:

UPS unit shall be of the double conversion topology and provide a true sine-wave output with minimum 1500 Volt-Amp continuous capacity. UPS must provide for utility service isolation when in operation. The maximum output rating will be 1050 watts. The UPS shall be capable of running an intersection with LED lights (for Run Time consult manufacturer). The unit shall operate on-line, with 0 transfer time, with battery status indicator, with selectable High-Efficiency Mode Option, with automatic test provisions, and with hot-swappable batteries (all batteries in system). UPS will automatically recharge batteries from full discharge to 90% capacity within 8 hours. UPS will provide on-line operation for a minimum input of 80 to 144 VAC, provide full load output of 120VAC (+/- 2% Regulation) at 50Hz or 60 Hz +/- 0.05% over a temperature range of -37° C (-34.6° F) (optional adder) to +74° C (165.2° F) (de-rate unit power capacity to 1200VA / 800W above 60°C and below -20°C), and conform to and be based on a UL Approved Design. Unit will offer a

For safety and maintenance the inverter shall not exceed 22 pounds. The UPS unit will be delivered with maintenance manuals.

UPS UNIT MINIMUM FEATURES:

- 1500VA 1050 Watts, with quick make/break connectors and plugs. (Systems requiring hard wiring termination to/from the inverter are unacceptable).
- Surge energy - Per IEEE 62.41 (formerly IEEE 587)
- Common mode clamping 0 ns < 5ns typical UL 1449
- Continuous True Sine Wave 120V AC Output
- Transient lighting protection – Per IEEE 62.41 (formerly IEEE 587)

- Each battery shall be 24 volts @ 18 AH with heavy duty Anderson plugs connections to the UPS for greater system reliability and ease of maintenance. Series wiring is unacceptable.
- Fan cooling shall be fused for locked rotor current.
- Cooling air shall be ducted to cool the front and back of each battery with air space on all four sides and top of battery.
- Inverter covers shall be 60% open on both sides to diminish the environmental effects of extreme temperatures.
- Includes USB & RS232, DB9 Computer Interface Ports.
- Low voltage safety design at 24V DC. (Higher voltage DC systems are unacceptable).

UPS COMMUNICATIONS MODULE:

All inverter connections shall be made without the use of tools. This includes: A/C-Input, A/C- Output, Normally-Open, and Normally-Closed programmable contacts.

Smart Slot Relay I/O Module; Input #1 Turn the UPS on.

Input #2 Turn the UPS off. Input #3 Start the UPS self-test.

Input #4 Shut down the UPS (when on battery).

Output #1 The UPS is on-battery (during a power failure, self-test or run time calibration). Output #2 UPS has a low battery – Programmable.

Output #3 The protected load is not receiving power from the UPS. Output #4 Replace the UPS batteries.

Output #5 The UPS is overloaded.

Output #6 Any UPS fault or self-test failure.

BATTERIES:

Batteries shall be maintenance-free, type AGM/VRLA (Absorbed Glass Mat / Valve Regulated Lead Acid) or Gel Cell. Batteries shall be independently pre-wired and individually fused. Batteries shall be furnished with heavy-duty 50 amp rated silver-plated Anderson Connectors. 100 Amp internal fuse by Battery supplier. Batteries shall be lightweight for personnel safety and protection plus ease of installation and maintenance. Batteries shall weigh a minimum of 26.5 lbs.

ENCLOSURE TEMPERATURE COMPENSATION:

Operating temperature shall be a minimum -37° C (-34.6° F) to +74° C (165.2° F).

POWER SYSTEM ANALYZER AND CONFLICT RESOLUTION MODULE:

The inverter incorporates an integrated power system analyzer and conflict resolution system. The analyzer will evaluate and make limited adjustments to the incoming utility power and will automatically transfer load to the battery back-up power if utility power is lost. When utility power becomes available, the UPS will analyze the power to verify stability and return to normal operation. The system provides automatic UPS failure detection and automatically isolates the failed UPS and locks the unit on to utility power. Once the failure has been corrected, the system will return to normal operation.

TRIPLE BYPASS SYSTEM FOR OFFLINE UPS:

1. Power Analyzer with Conflict Monitor Isolation and Transfer Module.

2. PCM – Power Conflict Monitor. The PCM is a totally redundant failsafe system. It monitors load bus power available continuously. If load bus power fails for 5ms the PCM will transfer and isolate the UPS and guarantee that commercial power will be locked on.

3. Timer – Redundant 5 ms delay and hard transfer to utility power.

4. The onboard Transfer Switch shall not interrupt the normal controller function. Transfer time shall be 2ms.

5. Onboard I/O module will execute lockout of battery back up system upon detection of any inverter UPS fault. If UPS resets itself, it will automatically be available for backup.

6. ON Inverter to timed relay for Full Time control of Output, 0 to 10 hours.

BATTERY CHARGER:

Shall charge from shut off discharge to 90% fully charged in less than 8 hours. The battery charger shall utilize Advanced Battery Management to extend battery life.

ADVANCED BATTERY MANAGEMENT:

Protection at the cellular level means longer battery life – Improved reliability results from a precision battery charging system, and automatic true-load battery tests. Redundant overcharge protection contributes to longer battery life. Undervoltage Boost and Overvoltage Buck regulates under and over voltages without switching to battery.

Battery Replacement Warning prevents downtime – The Inverter is capable of performing a self-test every two weeks. This ensures that you will be alerted to degrading batteries before they wear out. Through software, or the push of a button, self-tests may be performed at anytime. Faster Recharge Time – The inverter battery charging systems are microprocessor controlled to precisely charge batteries in less time than legacy UPS systems. This makes the system available more quickly for subsequent power disturbance.

HOT-SWAPPABLE BATTERY REPLACEMENT:

The user friendly, hot-swappable battery replacement system allows safe and easy replacement of batteries while your system is up and running.

WARRANTY:

Manufacturers shall provide a two (2) year factory-replacement parts warranty on the UPS. Batteries shall be warranted for full replacement for two (2) years. The warranty shall be included in the total bid price of the UPS.

Add to the list in the 2nd paragraph of section 86-1.02R(4)(a):

4. Be made of metal

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87 ELECTRICAL SYSTEMS

Replace the 1st sentence in the 10th paragraph of section 87-1.03A with:

The shutdown of traffic signal systems in the City of West Sacramento is allowed only between the hours of 9:00 a.m. and 3:00 p.m.

Replace the 22nd paragraph of section 87-1.03A with:

The City places identification characters on the electrical equipment.

Replace the 3rd paragraph of section 87-1.03C(2)(a) with:

Install a pull box on a bed of crushed rock.

Replace the 2nd paragraph of section 87-1.03H(2) with:

Use Method B to insulate a splice.

5th StreetC Street

3rd StreetC Street

Jibboom StreetRailyards Boulevard

Bercut DriveRailyards Boulevard

When the extended pushbutton press is used, program the signals with messages for each street as follows:

1. During the pedestrian clearance interval, the message heard must be *Wait to Cross* C Street. *Wait.*
2. During the pedestrian clearance interval, the message heard must be *Wait to Cross* 5th Street. *Wait.*
3. During the pedestrian clearance interval, the message heard must be *Wait to Cross 3rd Street*. *Wait.*
4. During the pedestrian clearance interval, the message heard must be *Wait to Cross Railyards Boulevard*. *Wait.*
5. During the pedestrian clearance interval, the message heard must be *Wait to Cross Jibboom Street*. *Wait.*
6. During the pedestrian clearance interval, the message heard must be *Wait to Cross Bercut Drive*. *Wait.*

Add between the 9th and 10th paragraphs of section 87-1.03V(2):

Use hot-melt rubberized asphalt sealant to fill slots.

Add to the end of section 87-21.03C:

Modifying a lighting system includes removing, adjusting, or adding:

1. Foundations

2. Pull boxes
3. Conduit
4. Conductors
5. Standards
6. Luminaires
7. Service equipment enclosure
8. Photoelectric control
9. Fuse splice connectors

Modifying a signal and lighting system includes removing, adjusting, or adding:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors
5. Cables
6. Standards
7. Signal heads
8. Service equipment enclosure
9. Controller assembly
10. Detectors
11. Accessible pedestrian signals
12. Push button assemblies
13. Pedestrian signal heads
14. Luminaires
15. Photoelectric control
16. Fuse splice connectors
17. Battery backup system
- ~~18. Telephone demarcation cabinet~~

Add to section 87:

87-22 BRIDGE AESTHETIC LIGHTING

87.22-01 COMMON WORK RESULTS FOR BRIDGE AESTHETIC LIGHTING ELECTRICAL

87.22.01A General

87.22.01A(1) Summary

This Section describes the general requirements for the electric work. These requirements apply to all sections of Division 87-22 Bridge Aesthetic Lighting.

87.22.01A(2) Description

Provide all equipment and materials for a complete, operational electrical system as described in 87-22 Bridge Aesthetic Lighting and shown on the plans.

87.22.01A(3) Code Compliance

Perform all work in accordance with the following codes. The latest adopted edition, or supplement, or amendment thereto in effect at the time of submittal to the building department must be considered to be the issue in effect of all applicable laws, codes, and regulations including, but not limited to:

1. California Electrical Code (CEC)
2. California Building Code (CBC)
3. California Fire Code (CFC)
4. California Building Standards Administrative Code (CCR)
5. Title 19, California Code of Regulations, Public Safety, State Fire Marshal Regulations

6. Occupational Safety and Health Act (OSHA)
7. California Green Building Standards Code
8. All Applicable State Local Codes and Regulations
9. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association.
10. California Energy Code

87.22.01A(4) Permits, Fees and Inspections

Obtain all permits that are required for the work.

Call for all local building department inspections.

Obtain approvals from AHJ inspector prior to final observation by Engineer.

Advise Owner Representative, one week prior to:

1. Start of interior rough-in work.
2. Start of wire pulling.
3. Installation of panels.
4. Installation of lighting fixtures and lighting controls.
5. Installation of wiring devices.

87.22.01A(5) Standards

Comply with the current applicable standards of the listed agencies for electrical materials and installation.

Underwriters Laboratories, Inc. (UL): Provide a UL label or evidence of UL listing for all electrical material, unless the material is of a type for which a label or listing service is not provided.

National Electrical Manufacturer's Association (NEMA).

American National Standards Institute (ANSI).

American Society for Testing Materials (ASTM).

Insulated Power Cable Engineers Association.

Certified Ballast Manufacturer's Association.

Institute of Electrical and Electronic Engineers (IEEE).

Telecommunications Industry Association (TIA).

Caltrans Standard Specifications, 2024.

87.22.01A(6) Submittals

Provide submittals for electrical equipment and materials in accordance with the Contract's General Conditions.

Procedure: Submit under provisions of the contract's General Conditions. Provide submittals for items listed documenting compliance with specification requirements.

1. Test Reports: Reports of field tests, continuing copies of the test results, in tabulated form with the signature of the responsible person.
2. Insulation resistance.

3. Operation and Maintenance Manual, in accordance with the contract's General Conditions.
4. Record Drawings, in accordance with the contract's General Conditions.

87.22.01A(7) Action Submittals

Submit manufacturers' data and shop drawings in accordance with General Requirements.

87.22.01A(7)(a) Product Data: For each type of equipment

Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

87.22.01A(7)(b) Shop Drawings: For each equipment and related equipment.

Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.

Plan drawings to indicate clearances between equipment, adjacent surfaces, and other items. Comply with indicated minimum code and manufacturer required clearances.

Include equipment weight and location of center-of-gravity for each section.

87.22.01A(7)(c) Field Quality-Control Submittals:

Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

87.22.01A(8) Information Submittals

Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

Sample warranties.

87.22.01A(9) Closeout Submittals**87.22.01A(9)(a) Warranty documentation.****87.22.01A(9)(b) Operation and Maintenance Manuals:**

1. Furnish in accordance with the contract's General Conditions.
2. Furnish set of operation and maintenance manuals prior to final inspection, electronically and bound in 8-1/2 x 11-inch three-ring side binders with durable plastic covers.
3. Provide a separate section for each system, with a table of contents and index tabs for each volume.
 - a. Part 1: Directory, listing names and email addresses and telephone numbers of Electrical Engineer and Electrical Subcontractor.
 - b. Part 2: Operation and maintenance instructions, arranged by system. For each system, give names, email addresses, addresses, and telephone numbers of suppliers and factory service representatives. Incorporate the following:
 - 1) Complete instructions regarding operation and maintenance of all equipment involved.

- 2) Complete nomenclature of all replaceable parts, their part numbers, current cost, and name email addresses and address of nearest vendor of parts.
 - 3) Copy of all guarantees and warranties issued.
 - 4) Copy of all letters of compliance or certification issued.
 - 5) Copy of the approved shop drawings with all data concerning changes made during construction.
 - 6) Conduit and wiring diagrams. Terminal designation on diagrams must correspond to the actual field installation.
 - 7) Names, email addresses, addresses, and telephone numbers of manufacturers, manufacturer's representatives, service facilities, and normal channels of supply.
4. Extraneous Data:
- a. Where contents of manuals include manufacturer's catalog pages, clearly indicate the precise items included in this installation and delete, or otherwise clearly indicate, all manufacturer's data with which this installation is not concerned.

87.22.01A(9)(c) Record drawings

1. The Contractor must maintain at the job site office an up to date daily as-built drawing set showing actual installation of the electrical system and equipment. This set shall contain approved changes and shall be kept clean, up to date, and in good condition. Incomplete as-built markups will be returned to the Contractor for additional documentation of installation; any additional time tracing and documenting information will be at the Contractor's expense.
2. Use this set of drawings for no other purpose.
3. Where any material, equipment, or system components are installed differently from that shown, indicate differences clearly and neatly using ink or indelible pencil or electronically.
4. At project completion, submit record set of full-size drawings, electronically marked to show final as-built conditions. These must be turned over to the Owner Representative upon completion.

87.22.01A(10) Maintenance Material Submittals

Special Tools: Furnish to Owner proprietary equipment, keys, software, usernames, and password required to operate, maintain, repair, adjust, or implement future changes to equipment, that is packaged with protective covering for storage on-site and identified with labels describing contents.

87.22.01A(11) Delivery, Storage, and Handling

Deliver equipment in sections or lengths that can be moved past obstructions in delivery path.

87.22.01A(12) Materials and Substitutions

Provide new material of the quality specified and satisfactory to the Owner Representative.

Provide major equipment which is the product of a manufacturer who has, for a period of not less than five years been in successful manufacture of similar equipment to that specified and who has a catalog covering ratings and specifications of proposed equipment.

87.22.01A(13) Drawings and Specifications

Data given herein and on the plans are exact as could be secured, but their absolute accuracy is not guaranteed. Plans and specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, and other data will be governed by the structures.

Clarification of plans and specifications for the purpose of facilitating construction, but not involving additional labor and materials, may be prepared during construction by the Engineer and authorized by the

Owner Representative. Said revised plans and specifications must become a part of the contract. The Contractor must conform to the revised plans and specifications at no additional cost to the Owner.

Layouts of equipment, accessories, and wiring systems are diagrammatic but follow these as closely as possible. Examine Architectural, Structural, Mechanical, and other drawings, noting all conditions that may affect this work. Report conflicting conditions to the Owner Representative for adjustment before proceeding with the work. Should the Contractor proceed with work without so reporting the matter, they do so, on their own responsibility and must alter work if directed by the Owner at their own expense.

The right is reserved to make minor changes in the locations of equipment and wiring systems shown, providing the change is ordered before conduit runs and/or work directly connected to same is installed and no extra materials are required.

87.22.01A(14) Supervision

Provide adequate and competent supervision. Maintain complete control of the project execution and complete liability for the materials and work until the job is completed and accepted by the Owner.

87.22.01A(15) Manufacturer's Instruction

Follow the manufacturer's instructions when specific installation or connection details are not indicated or specified.

Notify the Engineer of conflicts between the manufacturer's instructions and installation or connection details prior to the installation of materials.

87.22.01A(16) Workmanship

Installation methods must be as recommended by the National Electrical Contractors' Standard of Installation, except when methods specified or shown on the plans differ. The minimum installation standards must be as required by the Codes.

87.22.01A(17) Protection

Protect all equipment and materials required for the performance of this work from damage by the elements, vandalism, or work during construction.

Do not subject the work and materials of other trades to damage during execution of the work in this division of the specifications.

87.22.01A(18) Coordination With Other Trades

Coordinate with other trades and promptly transmit all information required by them. Coordinate the sequence of construction with other trades to ensure that all work proceeds with a minimum of interference and delay. Perform all work that requires relocation due to negligence or absence of regard for the work of other trades.

87.22.01A(19) Examination of Site

Examine the site prior to bid to determine existing site conditions that may affect the work. No allowance will be allowed for any extra work required due to a failure to recognize, or negligence to discover conditions prior to bid.

87.22.01A(20) Structural Requirements

Secure all anchors for electrical equipment in a manner that will not decrease the structural value of any structure to an unsafe level. Inform the Structural Engineer of any proposed modifications to the structure that involves cutting or patching of concrete, masonry, steel, or wood in the project.

87.22.01A(21) Demonstrations:

After testing and final inspection, demonstrate operation of listed systems and equipment to Owner Representative.

Arrange date of test with Owner Representative.

Advise the manufacturers' representative to be present when required.

Instruct Owner's personnel in operation, adjustment and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

87.22.01A(22) Guarantee:

Guarantee the electrical work against defects in work or materials for a minimum of one year after filing of Notice of Completion.

Undertake repairs within 24 hours after notice from the Owner.

If the operation of the electrical system fails to conform to Division 26 requirements, approved submittals, or operation and maintenance manuals, the Owner may operate the electrical system without liability to Owner. Repair or replace defective or unsatisfactory equipment or systems.

87.22.01B Products (Not Used)

87.22.01C Execution

87.22.01C(1) General

All electricians to be state certified and apprentices in an approved training program.

When changes in location of any work are required, obtain approval of Owner Representative before making changes. Make minor changes at no extra cost.

Do not change indicated sizes without written approval of Owner Representative.

Provide all necessary offsets and crossovers in conduits, raceways, cabletrays and ducts.

87.22.01C(2) Quality Assurance and Project Safety

Provide quality assurance and project safety programs. Satisfy the minimum acceptable requirements provided in the specifications.

87.22.01C(3) Preparation

Examine Drawings and Site; be familiar with types of construction where electrical installation is involved.

Work must be neatly installed in a professional manner in accordance with NECA Standard of Installation. Work must be coordinated with other trades to avoid conflicts. Clarifications will be made by Owner Representative and minor adjustments shall be made without additional cost to Owner. Obtain clarification from Owner Representative concerning any obvious discrepancies or omissions in work before bidding. All work involved in correcting obvious errors or omissions after award of Contract must be performed as directed by Owner Representative without additional cost to Owner.

87.22.01C(4) Working Space

Provide adequate working space around electrical equipment in compliance with OSHA Article 4 of Electrical Safety Orders. Provide CEC required clearance in front of all electrical equipment.

87.22.01C(5) Product Delivery, Storage, Handling, and Protection

Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material including Owner furnished material. Handle materials in accordance with manufacturer's applicable standards and suppliers' recommendations, and in a manner to prevent damage to materials. Store packed materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and must be removed from the premises and replaced at no additional cost to the Owner.

All material must be stored in an enclosed, dry building or trailer. Provide temperature and humidity control to meet manufactures requirements. No material for interior installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above must be removed from the premises and replaced at no additional cost to the Owner.

Equipment and materials must not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials that are damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced at no additional cost to the Owner.

87.22.01C(6) Care and Cleaning

Remove oil, dirt, grease, metal shavings, knockouts, wiring scraps and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touch-up scratched or marred surfaces of lighting fixtures, panelboard and cabinet trim, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

Accessible elements of disconnecting and protective devices of equipment, coils of dry type transformers and the like shall be cleaned with compressed air (less than 15 PSI) and the enclosures vacuum cleaned prior to being energized.

Clean light fixtures and lamps thoroughly, just prior to final inspection. Fixture enclosures, shielding, etc., shall be cleaned by an approved method.

All broken, damaged, or otherwise defective parts must be repaired or replaced without additional cost to the Owner. Work must be left in a condition satisfactory to Owner Representative. At completion, carefully clean and adjust all equipment, fixtures and trim installed as part of this work. Systems and equipment must be left in a satisfactory operating condition.

All surplus materials and debris resulting from this work must be periodically cleaned out and removed from site; this includes surplus excavated material.

87.22.01C(7) Cutting and Patching

Provide necessary cutting and patching required to accomplish the work.

Do not endanger the stability of the structure by cutting, drilling, or otherwise modifying the structural members. Direct all requests for structural modifications to the Owner Representative for approval. Proceed with these modifications only as directed by the Owner Representative.

Cutting and patching requirements will be modified only if General Construction Specifications and drawings specifically state that certain portions or all cutting and patching required for each of the various trades is to be performed.

Refer to General Construction Specifications for execution and requirements for patching and painting and comply with applicable provisions as to materials and quality of installation.

87.22.01C(8) Protection

In performance of work, protect work from damage. Protect electrical equipment, stored and installed, from dust, water or other damage.

87.22.01C(9) Equipment Identification

Panelboards, switches, terminal boxes, etc., must be properly identified.

87.22.01C(10) Rust Inhibiter

Channels, joiners, hangers, caps, nuts and bolts and associated parts shall be plated electrolytically with zinc followed immediately thereafter by treating freshly deposited zinc surfaces with chromic acid to obtain a surface which will not form a white deposit on surface for an average of one hundred twenty (120) hours when subjected to a standard salt spray cabinet test or shall be hot dipped galvanized.

87.22.01C(11) Electrical Systems Operational Tests, Manufacturers Systems Certification and Design Authority Assistance**87.22.01C(11)(a) Testing:**

Provide tests specified in other sections. Test all wiring and connections for continuity and grounds; where such test indicates faulty insulation or other defects, locate, repair and retest. Balance loads at panelboards. Furnish all testing equipment.

Prior to energization of equipment, check the insulation resistance of feeders, with a 500-volt "Megger".

Tests:

1. Grounding systems, for resistance to earth. Provide additional grounding electrodes if main service or separately derived system ground resistance exceeds 5 ohms.
2. Coordinate phase rotation of all motors and panels with installer to ensure proper direction of rotation.

Prior to the final inspection, the systems or equipment must be tested and reported as specified therein. An electronic copy of the tests shall be submitted to the Owner Representative for approval. Testing does not replace the requirement for final inspection of the project work.

Take precaution during the testing period to ensure the safety of personnel and equipment.

All electrical systems must be tested for compliance with the specifications.

87.22.01C(11)(b) Manufacturers Certifications:

The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers recommendations and system operation.

87.22.01C(11)(c) Design Authority Assistance:

Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.

Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Owner Representative.

87.22.01C(11)(d) Closing of Uninspected Work

Do not allow or cause any work installed hereunder to be covered up or enclosed before it has been inspected and approved.

Should any work be enclosed or covered up before it has been approved, uncover such work and after it has been inspected and approved, make all repairs necessary to restore work of others to conditions in which it was found at time of cutting, all without additional cost to the Owner.

87.22.01C(11)(e) Temporary Facilities

Provide temporary shop office and storage space on site only at locations approved by the Owner Representative. Remove these facilities upon completion of work.

87.22.01C(11)(f) Noise And Vibration

Cooperate in reducing objectionable noise or vibration. If noise or vibration occurs as a result of the use of improper material or installation, correct these conditions at no cost to the Owner.

87.22-02 87.22.02 SUPPORTING FROM STRUCTURE**87.22.02A General****87.22.02A(1) Description**

This specification defines the seismic design criteria to be used for the design of equipment anchorage and seismic bracing for electrical equipment/components. This section provides guidelines and limitations for supporting all electrical items from the structure, and for seismic bracing for all such items.

The Contractor is responsible for engaging the services of a qualified licensed professional engineer in the state of California with a minimum of 5 years of experience in structural seismic design to provide the analysis, calculations, seismic bracing, and installation details for equipment and equipment anchorage, in accordance with specified criteria and applicable codes. The Contractor's engineer is to provide construction support during the equipment installation for any field problem that may arise during construction. The Contractor is required to design support and bracing for items for which the contract documents do not provide specific attachment, support, and bracing.

Unless the item is classified by the owner as essential, seismic bracing and restraint may be waived for the following.

1. Anchorage for equipment with operating weighs less than 400 pounds and is supported at 4 feet or less above the floor.
2. Temporary or movable equipment when rolling/sliding is prevented and is not subject to tipping.
3. Equipment weighing less than 20 pounds supported on vibration isolators.
4. Equipment weighing less than 20 pounds suspended from the floor or roof or mounted to walls.
5. Verification and investigation on Item C.2, whether the equipment will be tipped over under the code required seismic forces using $R=1.0$ and 60% of the operating weight, shall be performed by a qualified engineer per Paragraph 1.01B.

Seismic bracing is not required for the following items:

1. All electrical conduits less than 2.5 inches inside diameter, unless racked together.
2. All conduits mounted less than 12" from hanger anchorage.

Design and install all support and bracing systems except as noted. Provide for attachment to portions of the building structure capable of bearing the loads imposed. Design systems to not overstress the building structure.

87.22.02A(2) Related Requirements**87.22.02A(2)(a) Structural Specifications.****87.22.02A(3) References**

American Society of Civil Engineers (ASCE), ASCE 7, Minimum Design Loads for Buildings and Other Structures,

American Society of Heating and Ventilating and Air Conditioning (ASHRAE), HVAC Applications, Latest Edition, Seismic and Wind Restrain Design

1. The lateral force equations in ASCE 7, as appropriate, should be used to determine the lateral seismic force. The force calculations found in these standards are based on a previous code provision that may not comply with the latest ASCE 7.

American Society of Mechanical Engineers (ASME), including addendum through the latest edition

Structural Engineers Association of California, Recommended Lateral Force Requirements and Commentary, Latest Edition

Seismic Restraint Manual Guidelines for Mechanical Systems, Latest Edition (SMACNA)

87.22.02A(3)(a) Design Requirements

1. All electrical equipment/devices, attachments and supports shall be designed to withstand the specified seismic loads and comply with the latest ASCE 7 seismic design detailed requirement for strength and displacement.
2. Equipment design is solely the responsibility of the equipment supplier. The equipment shall be designed so the strength and anchorage of the internal and external components or equipment piping exceed that of the forces used to restrain and to anchor the equipment to the supporting structure. Guidance as to which pieces of equipment and parts require seismic design can be found in the commentary section of SEAOC Recommended Lateral Force Requirements and Commentary, specifically Section C107. Equipment with flexible and /or cantilevered lateral systems shall be avoided.
3. Seismic design parameters as defined by the latest ASCE 7.
 - a. R_p for anchorage shall consider the ductility and the embedment depth of the anchor.
 - b. Additional factor for anchorage to cracked concrete and masonry structure shall be applied as required by codes.
4. Components and Equipment Supported by Structures
 - a. The lateral force is to be applied at the center of mass of the component and can act in any lateral direction.
5. Seismic restraint for electrical systems is to be designed per the latest ASCE 7 - seismic design requirements.

87.22.02A(3)(b) Connection Requirements

1. Component attachments are to be welded, bolted, or otherwise positively connected without consideration of frictional resistance resulting from gravity loads. Do not weld on any joists or beams without written approval from Structural Engineer.
2. Attachments to concrete shall be made with anchors suitable for cyclical loads. Expansion or chemical anchors not rated for Seismic Design Category "D", "E" & "F" shall not be used for seismic anchorage.
3. Powder driven fasteners shall not be used for tension load applications.
4. Friction clips shall not be used for anchorage.
5. Welded plate washers with standard holes shall be used at bolted connections with oversized holes on the base plate.
6. Unless the base sheet metal is reinforced with stiffeners and is designed to take the bending from the uplift forces, oversized plate washers shall be used at bolted connection through the base sheet metal.
7. Isolators must be designed to withstand the seismic loads. Provide snubbers if the isolator cannot withstand the specified load and see below for the design force.
8. Components mounted on vibration isolator system shall have a bumper restraint or a snubber in each horizontal direction. The design force is to be taken as $2F_p$ unless the nominal clearance (air gap) between the frame and restraint is equal or less than 0.25".

87.22.02A(3)(c) Refer to structural drawings for material specifications of structure. If no structural drawings are available, assume 3000 psi concrete and ASTM A36 steel for attachment design and confirm these values with Structural Engineer before proceeding with the design

87.22.02A(3)(d) Deformation Compatibility

1. The design and detailing of anchorage and restraints shall accommodate following building drift.
 - a. Lateral deformation within the Structure 0.010 times height for the code design basis seismic event.
 - b. Vertical deformation compatibility crossing the base isolation boundary ± 1 inch
2. Do not brace any equipment to parts of structure which may respond differently during earthquake. Do not pass seismic bracing through building expansion and contraction joints.
3. The equipment frame inelastic displacement due to the seismic loads shall not exceed the codes' allowable displacement, and it shall be limited so as not to damage any piping and accessories attached to it.

87.22.02A(4) Submittals

87.22.02A(4)(a) Calculations and Drawings.

1. Submit structural calculations and a separate drawing stamped and signed by the California Licensed Professional Engineer in good standing. The calculations and drawings shall include the following information as minimum.
 - a. Empty weight
 - b. Operating weight
 - c. Center of mass in plan
 - d. Center of mass in elevation
 - e. Seismic vertical, lateral, and overturning loads
 - f. Impact loads
 - g. Vibration loads
 - h. Load combinations in accordance with applicable codes
 - i. Foundation reactions
 - j. Isolator reactions where isolators are used
 - k. Anchor bolt brand, type, size, embedment depth in concrete, grip distance, and locations, including specific drilling and special inspection requirement
 - l. Platform design layout, structural loads, material list, and connection details
 - m. Installation sequence if it requires specific sequence to fasten the anchorage
2. Coordination drawings to demonstrate interface with adjacent systems including location and space required for seismic bracing and anchorage.
3. Furnish certification letter in the calculations stating the design of the equipment components and anchorage comply with the seismic design requirement per ASCE 7 13.2.2.a. and applicable local building codes.

87.22.02A(4)(b) Installing contractor to submit following reports to Structural Engineer and Building Official

1. Bolt inspection reports for field installed bolts for structural components including the location of the test, date of the test, bolt diameter, and recorded torque.
2. Non-destructive testing program for welding and anchors.

3. Field weld inspection reports for structural welds including the type of weld, location of the weld, nondestructive testing procedure and results, welder certification, qualified welding description or number in accordance with the latest AWS D1.1.
4. Reports covering other structural activities requiring inspection in accordance with the applicable local building codes.

87.22.02B Products

87.22.02B(1) Materials

Furnish all substructures and fasteners required to comply with the limitations given below. Use materials as specified in the various sections and as appropriate to the use.

All exterior materials: Hot dipped galvanized or stainless steel.

87.22.02C Execution

87.22.02C(1) Guidelines & Limitations

The General Contractor shall coordinate the load requirements from all subcontractors so that no combination of loads exceeds the limitations given below.

Steel Structure:

1. Attachments may be at the upper or the lower truss chord (horizontal members at top and bottom of truss). Hang no loads from web members (the diagonal and vertical members between chords), including the end diagonal member where the lower chord is discontinuous.
2. Make the point of attachment at a panel point of the truss girders or joints. (The panel points are the intersections of the horizontal chords with the diagonal or vertical web members.)
3. Make no attachments to metal decking.
4. Do no welding on any trusses. Use bolted or clamped type connections.
5. At W beams and truss girders, hang all loads greater than 40 pounds Concentric.
6. Attach no loads greater than the following without specific approval of Engineer.
 - a. Floor girders: 500 pounds points load. 1000 pounds total for a single span.
 - b. Roof girders: 300 pounds points load. 600 pounds total for a single span.

Other Structures: Coordinate with the Structural Engineer of Record for criteria.

87.22.03 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

87.22.03A General

87.22.03A(1) Summary

The work required under this section of specifications consists of furnishing, installing and connecting the wiring system included in the bridge aesthetic lighting scope of work, 600 volts and below.

Exterior branch circuit wiring and feeder conductors extended beyond the building are included.

87.22.03A(2) Reference Standards

Perform all work in accordance with the following. The latest adopted edition, or supplement, or amendment thereto in effect at the time of submittal to the building department must be considered to be the issue in effect:

1. American Society for Testing and Materials (ASTM):
 - a. ASTM B3-13 Standard Specification for Soft or Annealed Copper Wire.

- b. ASTM B8-23 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - c. ASTM B33-10 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
 - d. ASTM B787/B787M-04 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - e. ASTM B800-05 Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes – Annealed and Intermediate Tempers.
 - f. ASTM B801-18 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation.
2. Federal Specification (FS):
- a. FS A-A-59544 Cable and Wire, Electrical (Power, Fixed Installation).
3. InterNational Electrical Testing Association (NETA):
- a. NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
4. National Electrical Manufacturers Association (NEMA):
- a. NEMA, WC 70 Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy.
5. Underwriters Laboratories (UL):
- a. UL 44 Communication Cable
 - b. UL 83 Standard for Thermoplastic-Insulated Wires and Cables
 - c. UL 719 Nonmetallic-Sheathed Cables
 - d. UL 854 Service-Entrance Cables
 - e. UL 1277 Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

87.22.03B Products

87.22.03B(1) Conductor And Cable General Requirements

Provide products listed, classified, and labeled as suitable for the purpose intended.

Provide conductors and cables with lead content less than 300 parts per million.

Provide new conductors and cables manufactured not more than one year prior to installation.

Comply with NEMA WC 70.

Comply with FS A-A-59544 where applicable.

Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.

Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

Conductors for Grounding and Bonding: To Comply with Section "Grounding and Bonding for Electrical Systems."

Conductor Material:

1. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3-13, ASTM B8-23, or ASTM B787/B787M-04.
3. Tinned Copper Conductors: Comply with ASTM B33.

87.22.03B(2) Wire And Cable

Conductor: Insulated copper, individual conductors, 98 percent conductivity, stranded.

1. Power conductors: 12 AWG minimum to 750 MCM, stranded.
2. Color code power conductors of wiring systems by means of colored insulation. Phase code conductors as listed:

Voltage	Phase A	Phase B	Phase C	Neutral	Ground
120/208	Black	Red	Blue	White	Green
120/240	Black	Orange	Blue	White	Green
277/480	Brown	Orange	Yellow	Grey	Green

Insulation:

1. Rated 600 volts at 90°C as follows:

Item	Location Type	Size (AWG)	Insulation Type
Branch Circuits	Dry & Damp	#12 to #4/0	THHN
	Wet	#12 to #4/0	THWN-2
Fixture Taps	Dry & Damp	#12	THHN
Feeders	Dry & Damp	#12 to #750 MCM	THHN
	Wet	#12 to #750 MCM	RHW-2 THWN-2 USE-2 XHHW-2
Controls	Dry & Damp	#14 to #10	THHN
	Wet	#14 to #10	THWN-2

87.22.03B(3) Wire Connections

Binding post screw, stud, bolt or bus as follows:

1. For #10 AWG and smaller conductors:
 - a. Compression type, nylon, self-insulated grip spade lugs:
 - 1) Thomas & Betts
 - 2) Panduit
 - 3) Or equal.
 - b. For #8 AWG to #750 MCM copper conductors:

- 1) Solderless lug type mechanical copper connectors, with hex-head or allen type compression set screws with configuration to suit application. Burndy QA series, or equal.
- 2) Compression type, uninsulated: Burndy YA series, or equal.

Conductor Taps:

1. For #12 through #750 copper conductors: mechanical type for stranded copper wire.
 - a. Burndy: KS, KS3, KVS, KVSW, QPX, or equal.
2. For #12- #4/0 copper conductors:
 - b. Compression C type, Burndy YC-C series, or equal.
3. For #4- #750 MCM cooper conductors:
 - c. Compression T type, Burndy YST or equal.

Connectors for splicing wire:

1. For #10 AWG and smaller conductors:
 - a. Twist-on solder-less, insulated spring connectors:
 - 1) 3M "Scotchloks"
 - 2) Thomas & Betts
 - 3) Or equal.
2. For #8 AWG to #750 MCM copper conductors:
 - b. Two-way connectors.
 - 1) Burndy: AMS or equal.
 - 2) Compression connectors.
 - a) Burndy: YS-L, YS, YS-T series or equal
3. Cast resin splice kit for underground applications.
 - c. 3M 85 series or equal.

87.22.03B(4) Tape

Wire Splices: Vinyl plastic electrical tape, 8.5-mil Scotch 33.

Conduit Wrapping: 10-mil vinyl wrapping tape, Manville, Minnesota Mining and Manufacturing Company.

87.22.03C Execution**87.22.03C(1) Insulated Conductors And Cable**

Install all wiring in raceway system, except where conductors are indicated or specified not to be installed in raceway. Any conductors found to be damaged or defective, including insulation damaged during installation, shall be removed and replaced at no expense to the Owner.

1. Pull conductors into raceway simultaneously where more than one is being installed in the same raceway.
2. Use UL listed pulling compound or lubricant where necessary to reduce cable pulling tension below the manufacturer's recommended levels. Compound used shall not deteriorate conductor or insulation.
3. Use pulling means, including fish tape, cable rope, or basket-weave wire/cable grips that will not damage cable or raceway.

Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torquing tool shall be used to insure proper torque application

Conductors shall be tested to be continuous and free of short circuits and grounds.

Maintain phase rotation established at service equipment throughout entire project.

Group and tie with cable ties (T & B "Ty-Rap", or equal) all conductors within all enclosures, (i.e., panels, motor controllers, equipment cabinets, switchboards, etc.)

Make splices in conductors only within junction boxes, wiring troughs and other enclosures as permitted by the California Electrical Code (CEC). Do not splice conductors in pull boxes, panel boards, safety switches, switchboard, switchgear, motor control center, or motor control enclosures.

Support conductors installed in vertical raceways at intervals not exceeding those distances indicated in the CEC and California Building Code.

1. Support conductors in pull boxes with Bakelite wedge type supports or "Kellem" grips or equal, provided for the size and number of conductors in the raceway.
2. Do not splice conductors in pull boxes used for vertical cable supports unless written permission for splicing is obtained.

Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway.

Conductor lengths for parallel circuits shall be equal. Do not configure isolated phasing in separate conduits for parallel conductors.

Install a minimum of 12" (300 mm) of slack conductor at each outlet.

Thoroughly clean conductors prior to installing lugs and connectors.

Secure portable cables in accordance with the CEC. Install strain relief devices to prevent tension on terminations if cable is pulled. Install cable grips on drops and connect to outlet box or structure. Leave slack cable loop at drop point.

Color code conductors by phase sequence A-B-C when looking into the front of the equipment from left-to-right, top-to-bottom or front-to-back. Provide conductors with the appropriate phase color or mark conductors with a minimum of 6 inches of phase tape on ends connected to terminals.

Identify all conductors with their respective circuit numbers at all boxes and terminals.

Connections:

1. Use twist-on solder-less connectors for splicing receptacle and lighting circuits #10 AWG wire size and smaller.
2. Splice #12 and #10 AWG stranded conductors with compression connectors.
3. Terminate conductors at motors with bolted connections, insulated with plastic tape.
4. For conductor taps #8 through #750 MCM, provide mechanical copper connectors.
5. For splices larger than #10 AWG, insulate and smooth the splice with insulation putty, tape with one half-lapped layer of 8.5-mil vinyl plastic electrical tape and two half-lapped layers of 7.0-mil vinyl plastic electrical tape.
6. Use cast resin epoxy splices for splices in underground pullboxes.
7. Wrap all wire and cable operating at 480 volts AC or more with electric arc and fireproofing tape where wires are installed with other wires or cables.

87.22-04 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

87.22.04A General

87.22.04A(1) Description

Provide all equipment and materials for a complete grounding system.

1. Power System Grounding.
2. Electrical Equipment and Raceway Grounding and bonding.

87.22.04A(2) Reference Standards

Perform all work in accordance with the following. The latest adopted edition, or supplement, or amendment thereto in effect at the time of submittal to the building department must be considered to be the issue in effect:

1. National Electrical Contractors Association (NECA):
 - a. NECA 1 Standard for Good Workmanship in Electrical Construction.
2. National Electrical Manufacturers Association (NEMA):
 - a. NETA GR 1 Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
3. InterNational Electrical Testing Association (NETA):
 - a. NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
4. Underwriters Laboratories (UL):
 - a. UL 467 Grounding and Bonding Equipment

87.22.04B Products

87.22.04B(1) Acceptable Manufacturers

Thomas and Betts

O-Z/Gedney

Raco

Blackburn

Or equal.

87.22.04B(2) Grounding and Bonding Requirements

Do not use products for applications other than as permitted by NFPA 70 and product listing.

Provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

Where conductor size is not indicated, size to comply with NFPA 70.

87.22.04B(3) Grounding And Bonding Components

General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467.

Conductors for Grounding and Bonding:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

87.22.04B(4) Materials

Ground Clamp: Water pipe connection, bronze two piece with serrated jaws, lug sized for grounding electrode conductor.

Connectors, Compression Type: Bronze or Copper, pretreated with conductive paste, sized for conductor to which applied.

Connectors, Exothermic Weld Type: Powder actuated weld. Bond made through exothermic reaction producing molten copper from premixed copper oxide and aluminum powder. Form bond in mold or crucible.

87.22.04B(5) General Branch Circuits Grounding

All grounding conductor wire shall be insulated green copper conductors.

All conduit bushings shall be grounding type.

All grounding connections shall be made with solderless lugs and nonferrous hardware.

87.22.04C Execution

87.22.04C(1) Examination

Verify that work likely to damage grounding and bonding system components has been completed.

Verify that field measurements are as indicated.

Verify that conditions are satisfactory for installation prior to starting work.

87.22.04C(2) Installation

Install products in accordance with manufacturer's instructions.

Perform work in accordance with NECA 1.

All exposed non-current carrying metallic parts of electrical equipment, metallic raceways systems, grounding conductor in nonmetallic raceways and neutral conductor of the wiring system shall be grounded. The ground connection shall be made at the main service equipment of each service and shall be extended to all required components of CEC.

Make grounding and bonding connections using specified connectors.

2. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

Identify grounding and bonding system components.

87.22.04C(3) Field Quality Control

Perform inspections and tests listed in NETA ATS for grounding systems.

Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

Submit detailed reports indicating inspection and testing results and corrective actions taken.

87.22.04C(4) General Branch Circuits And Feeders

All conduit systems, equipment housings, material housings, junction boxes, cabinets, motors, ducts, wireways, cable trays, light fixtures, portable equipment, and all other conductive surfaces shall be solidly grounded in accordance with the CEC to form a continuous, permanent and effective grounding system.

Install a separate green grounding conductor in all conduits, including feeder, branch circuit, and flexible; both metallic and non-metallic. The conduit systems shall not be used as the system equipment grounds. Size all grounding conductors per CEC unless a larger ground is indicated on the drawings.

All panelboards, junction boxes, pullboxes, wireways and equipment enclosures shall be bonded to the conduit systems.

Isolated ground receptacles shall have both an isolated ground conductor and a separate equipment grounding conductor.

87.22.04C(5) Separately Derived Sources

All secondary neutrals for the 120/208 volt wye services of dry type transformers shall be grounded to building steel. Connection shall be made with cable sized according to the CEC. Extend separately derived insulated ground to the transformer in rigid steel conduit.

87.22.04C(6) Flexible Raceway Grounding

Install a ground conductor inside all flexible raceways (e.g. flexible steel, liquid tight).

Bond the conductor to the enclosure or ground bus in the nearest box or access on either side of the flexible section.

General Grounding Requirements

All ground connectors shall be bronze of the clamp type. All clamp accessories such as bolts, nuts, and washers shall also be bronze to assure a permanent corrosion-resistant assembly. Make connections easily accessible for inspection, underground or concealed in floors or walls.

All ground cable splices, joints, and connections to ground rods shall be made with an exothermic welding process which shall provide a weld with current-carrying capacity not less than that of the conductors welded. Soldered connections shall not be used.

All ground wire shall be insulated with extra flexible stranded copper cables.

Neutrals throughout the system shall be solidly grounded.

Lighting and power panelboards shall be grounded by connecting a grounding conductor to the grounding stud of each feeder and branch circuit conduits with grounding bushings. Each grounding-type bushing shall have the maximum ground wire accommodation available in standard manufacturer for the particular conduit size. Connection to the bushing shall be with wire of this maximum size.

87.22-05 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**87.22.05A General****87.22.05A(1) Summary**

Provide electrical materials, installation and testing for the hangers and supports of electrical system components included in the bridge aesthetic lighting system scope of work.

87.22.05B Products**87.22.05B(1) Support And Attachment Components****General Requirements:**

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

1. Comply with MFMA-4.

Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

87.22.05B(2) Supporting Devices

87.22.05B(2)(a) Conduit Supports:

1. Straps, one hole galvanized or cadmium plated iron, T & B, Efcor, Appleton, or equal.
2. Clamp backs, nest backs, galvanized iron or cadmium-plated steel, Efcor, OZ, Steel City, or equal. Plumbers perforated strap, not acceptable.
3. Hanger Rod, 3/8-inch, minimum galvanized all-thread rod.

87.22.05B(2)(b) Conduit Racks:

1. Framing Channel, steel, hot-dip galvanized or electroplated, Kindorf, Unistrut, Superstrut, or equal.
2. Channels attached to building or structure surfaces, 14 gauge, 1-5/8 inches wide by 13/16 inches deep. Other channels, 12 gauge minimum, 1-5/8 inches wide by 1-5/8 inches deep, minimum.
3. Construct racks to limit deflection to 1/360 of span.
4. Load on trapeze, rod type hangers, concrete inserts and beam clamps, not to exceed 700 pounds per hanger. Provide rigid frames if load exceeds 700 pounds per hanger.

87.22.05B(2)(c) Outlet Boxes

1. Attach device boxes with adjustable bar type hangers screw fastened to two stud/ceiling joists on both sides of box.

87.22.05B(2)(d) Anchor Methods:

1. Hollow masonry anchors.
2. Solid masonry, malleable iron expansion anchors or preset inserts.
3. Metal surfaces, machine screws, bolts or welded studs.
4. Concrete surfaces or self-drilling anchors.

87.22.05C Execution

87.22.05C(1) Examination

Verify that field measurements are as indicated.

Verify that mounting surfaces are ready to receive support and attachment components.

Verify that conditions are satisfactory for installation prior to starting work.

87.22.05C(2) Installation

Install products in accordance with manufacturer's instructions.

Perform work in accordance with NECA 1 (general workmanship).

Provide independent support from structure. Do not provide support from piping, ductwork, or other systems.

Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

Secure fasteners according to manufacturer's recommended torque settings.

Remove temporary supports.

87.22-06 CONDUIT FOR ELECTRICAL SYSTEMS

87.22.06A General

87.22.06A(1) Summary

This section describes requirements for conduit raceways.

87.22.06A(2) Related Work

Section 87-22.04: Grounding and Bonding.

Section 87-22.02: Supporting from Structure

Section 87-22.05: Hangers and Supports for Electrical Systems

87.22.06A(3) Reference Standards

American National Standards Institute (ANSI):

1. C80.1 Specification for Rigid Steel Conduit, Zinc Coated
2. C80.3 Specification for Electrical Metallic Tubing, Zinc Coated

National Electrical Manufacturers Association (NEMA):

1. TC 2 Electrical Plastic Tubing (EPT), Conduit (EPC-40 and EPC-80) and Fittings

Underwriters Laboratories, Inc. (UL):

1. 1242 Intermediate Metal Conduit

Federal Specifications:

1. WW-C-581E Conduit, Metal Electrical Conduit. Steel, Zinc Coated

87.22.06B Products**87.22.06B(1) Raceways**

Rigid Steel Conduit:

1. ANSI C80.1, minimum size 3/4 inch.
2. Threaded fittings, galvanized.
3. Locknuts, 3/4 inch to 1-1/2 inch, heavy nut steel.
4. Locknuts, 1-1/2 inch and larger, malleable iron.
5. Insulated bushings, malleable iron, plastic or nylon insert, OZ "IBC" series, Efcor "56" series, Appleton "GIB" series or equal.
6. Three-piece conduit couplings, malleable iron, T & B "Erickson", Appleton "EC" series, OZ "4" series, or equal.

Flexible Metal Conduit:

1. Fabricate from galvanized steel strip, minimum size 1/2 inch.
2. Connectors, T & B "Tite Bite", with insulated throat, or equal.
3. Length, no greater than 6 feet. Allow slack for movement of connected equipment.

Liquid-tight Flexible Metal Conduit:

1. Fabricate from galvanized steel strip, jacketed with PVC, minimum size 1/2 inch.
2. Straight connectors, cadmium plated steel or malleable iron, insulated throat and neoprene sealing ring, OZ "4Q-IT" series, T & B "5330" series, Efcor "11-B" series, or equal.
3. Angle connectors, cadmium plated steel or malleable iron, insulated throat and neoprene sealing ring, OZ, T & B, Efcor, or equal, comparable to straight connectors.
4. Hardware, cadmium plated steel.
5. Length, no greater than 6 feet. Allow slack for movement of connected equipment.

87.22.06C Execution**87.22.06C(1) Installation**

Install products in accordance with manufacturer's instructions.

Install conduit in a neat and workmanlike manner in accordance with NECA 1.

All conduit shall be concealed except in crawl spaces, utility tunnels, gantries, shafts, equipment rooms and where required to connect to surface mounted electrical equipment and free-standing equipment, or as noted otherwise or as instructed by the engineer.

87.22.06C(1)(a) Conduit Support:

1. Secure and support conduits in accordance with CEC and Section 87-22.05 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

87.22.06C(1)(b) Connections and Terminations:

1. Use suitable adapters where required to transition from one type of conduit to another.

2. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
3. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

87.22.06C(1)(c) Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

Conduit Movement Provisions: Where conduits are subject to thermal expansion, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. Where conduits are subject to seismic movement, provide 6 feet max. flex conduit with grounding fittings on each end bonded with #6 green wire. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection (seismic expansion joint).

Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

Provide grounding and bonding in accordance with Section 87-22.04.

87.22.06C(2) Above Ground Raceway Systems

Install raceway systems, including conduits, hangers and support channels parallel or perpendicular to structural members in accordance with Section 87-22.05 Hangers and Support. Coordinate location of raceway systems with other Divisions prior to commencing installation.

Rigid Steel Conduit: Suitable for use in all locations.

Flexible Metal Conduit: Suitable for connection of recessed lighting fixtures, motors or other devices requiring flexible connections in dry locations.

Liquid-Tight Flexible Metal Conduit: Suitable for connection of motors and equipment in damp or wet locations.

87.22.06C(2)(a) Conduit Supports:

1. Support all conduits at intervals per Chapter 3 of the CEC for the selected raceway type (not to exceed 10-feet).
2. Support individual conduits with conduit hangers or clamp back and nest back, if required for entrance into the equipment.
3. Support multiple conduits, 2 or more in parallel, with framing channel and pipe clamps.

4. Spring steel fasteners may be used to fasten electrical metallic tubing to individual hanger wires, minimum #12 AWG, specifically used for hanging conduit, nothing else.

87.22.06C(2)(b) Conduit Bends:

1. Provide no more than (3) 90-degree conduit bends or the equivalent number of smaller radius bends in any conduit run between boxes or equipment.
2. Length of run: 400-feet maximum less 100-feet for each equivalent 90 degree bend.
3. Fabricate bends and offsets with a hickey or conduit bender designed specifically for use with the type of conduit to be bent, or use factory made bend.
4. Radius of Bends: Conduits 2" inside diameter or less the inside bend radius shall be at least 6 times the diameter. Conduits greater than 2" diameter the inside bend radius shall be at least 10 times the conduit diameter.

Cap conduits during construction to prevent entrance of foreign material.

Provide conduit-sealing bushings at conduit penetrations through exterior walls to seal against fluid and gas pressure around the conduit.

Fit all conduits that enter the enclosure of a switchboard, distribution panel, or motor control center with an insulated grounding bushing.

Install pull ropes in all empty conduits, #12 AWG in conduits 1 inch and smaller and 3/16 inch polypropylene rope in conduits 1-1/4 inch and larger.

87.22.06C(3) Underground Raceway Systems

Install all wiring and cables in raceways. Coordinate location of raceway systems with other Divisions prior to commencing installation. Provide excavation, clearances from other utilities, encasing, trenching, boring, backfill, compaction, patching, per Division 31 Site Preparation. Provide conduits per drawings.

87.22.06C(3)(a) Excavating And Backfilling

1. Excavate and backfill as required for installation of electrical work. Maintain all warning signs, barricades, flares and lanterns as required by the Safety Orders and local ordinances.
2. Excavation: Dig trenches straight and true to line and grade, with bottom clear of any rock points. Support conduit for entire length on undisturbed original earth. Backfill: All backfill material shall be local material free of rubble, rubbish or vegetation. Trenches shall be backfilled and compacted to 90% of maximum dry density at optimum moisture content in layers not to exceed 6" when compacted.
3. Minimum Coverage (depth) - Per CEC Table 300.5
4. Area of Influence- Do not install conduits parallel to structure footings in the area of influence. See structural drawings and specifications for the area of influence and the methods that conduits can cross a footing.
5. Drain Slope- Underground conduit shall be installed such that a .125" per foot min. slope exists at all points of the run to allow drainage and prevent the accumulation of water. Provide a drain slope of greater than .125" per foot when extending conduit away from a building.
6. Provide underground warning tape along entire conduit length.

87.22.06C(3)(b) Cutting And Patching

1. Provide necessary cutting and patching required to accomplish the work of Division underground 26. Restore all surfaces, roadways, sod, walks, curbs, walls, existing underground installation, etc., cut by installations to original condition in an acceptable manner.

87.22.06C(3)(c) Conduit Bends:

1. Provide no more than (3) 90-degree conduit bends or the equivalent number of smaller radius bends in any conduit run between boxes or equipment.
2. Length of run: 400-feet maximum less 100-feet for each equivalent 90 degree bend.
3. Fabricate bends and offsets with a hickey or conduit bender designed specifically for use with the type of conduit to be bent, or use factory made bend.
4. Radius of Bends: Conduits 2" inside diameter or less the inside bend radius shall be at least 6 times the diameter. Conduits greater than 2" diameter the inside bend radius shall be at least 10 times the conduit diameter.

Rigid Steel Conduit: Suitable for use in all locations. Where used underground, wrap with no less than 2 layers of half-lapped 10 mil vinyl pipe wrapping tape.

Provide conduit-sealing bushings at conduit penetrations through exterior walls to seal against fluid and gas pressure around the conduit. Ducts shall be sealed to resist liquid and gas infiltration at all maintenance holes and building entrances.

Install pull ropes in all empty conduits, #12 AWG in conduits 1 inch and smaller and 3/16 inch polypropylene rope in conduits 1-1/4 inch and larger.

87.22-07 BOXES FOR ELECTRICAL SYSTEMS**87.22.07A General****87.22.07A(1) Summary**

Provide electrical materials, installation and testing for electrical system components included in the bridge aesthetic lighting system scope of work.

87.22.07A(2) Description

This section describes requirements for outlet boxes.

87.22.07A(3) Reference Standards

NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.

NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008.

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

87.22.07B Products**87.22.07B(1) Boxes**

General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

87.22.07B(2) Pull And Junction Boxes

General: For all pull and junction boxes over 300 cubic inches, provide code gauge, sheet steel boxes which meet NEMA 1 standards for panelboard and terminal cabinet box construction, with screw type covers.

Ground Lug: Weld, before finish is applied, a grounding pad drilled for two bolted grounding lugs or two ground studs on the box interior.

Finish: Apply rust inhibiting prime coat and 2 coats of baked enamel, standard factory gray.

Hardware: Cadmium plated steel screws.

87.22.07C Execution

87.22.07C(1) Boxes And Cabinets

Place outlet boxes in a location as close to that shown on the plans as possible. Coordinate location of boxes with other Divisions.

Install junction boxes with covers in concealed areas accessible after installation. Do not install junction boxes flush with finish walls or ceilings unless specifically approved by the Engineer.

Attach surface boxes with:

1. Steel or malleable iron expansion anchors in concrete or solid masonry.
2. Wood screws in wood.
3. Toggle bolts in hollow walls or masonry.
4. Machine screws, bolts or welded studs in steel.

87.22-08 IDENTIFICATION FOR ELECTRICAL SYSTEMS

87.22.08A General

87.22.08A(1) Description

Extent of electrical identification work for electrical system components included in the bridge aesthetic lighting system scope of work is as outlined by this specification.

Types of electrical identification work specified in this section include the following:

1. Buried cable warnings.
2. Electrical power, control and communication conductors.
3. Operational instructions and warnings.
4. Danger signs.
5. Equipment/system identification signs.

87.22.08A(2) Quality Assurance

California Electrical Code (CEC) Compliance: Comply with CEC as applicable to installation of identifying labels and markers for wiring and equipment.

Underwriters Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

American National Standards Institute (ANSI) Compliance: Comply with applicable requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems".

National Electrical Manufacturer's Association (NEMA) Compliance: Comply with applicable requirements of NEMA Standard No's WC-1 and WC-2 pertaining to identification of power and control conductors.

87.22.08B Products**87.22.08B(1) Identification Requirements**

Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
2. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Branch panel boards.

Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 87-22.03.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

87.22.08B(2) Warning Signs and Labels

Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

Warning Signs:

1. Materials:
2. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

87.22.08B(3) Acceptable Manufacturers

Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Almetek,

2. Brady, W.H. Company,
3. Calipico Inc.,
4. Cole-Flex Corporation,
5. Direct Safety Company,
6. George-Ingraham Corporation,
7. Griffolyn Company,
8. Ideal Industries, Inc.,
9. LEM Products, Inc.,
10. Markal Company,
11. National Band and Tag Company,
12. Panduit Corporation,
13. Seton Name Plate Company,
14. Tesa Corporation,
15. Or equal.

87.22.08B(4) Electrical Identification Materials

Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, provide single selection for each application.

87.22.08B(4)(a) Color-Coded Plastic Tape:

1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2 inches wide.
 - a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

87.22.08B(4)(b) Underground-Type Plastic Line Marker:

Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

87.22.08B(4)(c) Cable/Conductor Identification Bands:

Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

87.22.08B(4)(d) Plasticized Tags:

Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4 x 5-5/8 inches, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

87.22.08B(4)(e) Self-Adhesive Plastic Signs:

Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

87.22.08B(4)(f) Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

87.22.08B(4)(g) Baked Enamel Danger Signs:

General: Provide manufacturer's standard DANGER signs of baked enamel finish on 20-gauge steel; of standard red, black and white graphics; 14 x 10 inches size except where 10 x 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

87.22.08B(4)(h) Engraved Plastic-Laminate Signs:

1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8 inch, except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

87.22.08B(5) Lettering and Graphics

General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

87.22.08C Execution

87.22.08C(1) Application And Installation

87.22.08C(1)(a) General Installation Requirements:

Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of CEC and OSHA.

Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

87.22.08C(1)(b) Conduit Identification:

Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated use white as coded color for conduit.

87.22.08C(1)(c) Box Identification:

After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits a red marker for critical circuits, an orange marker for life safety circuits, and a green marker for equipment circuits.

All junction and pull boxes for wiring systems above 600V shall be identified with high voltage warning labels installed every 20 linear feet in accordance with OSHA standards. All boxes shall also be painted red, see Section 09900 of the specifications.

87.22.08C(1)(d) Underground Cable Identification:

During back-filling/top-soiling of each exterior underground electrical, signal or communication conduits, install continuous underground-type plastic line marker, located directly over buried line at 6 to 8 inches below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16 inches, install a single line marker.

Install line marker for every buried conduit.

87.22.08C(1)(e) Cable/Conductor Identification:

Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to Section 16100 - Basic Materials and Methods of these specifications for color coding requirements.

87.22.08C(1)(f) Operational Identification and Warnings:

Wherever required by OSHA or directed by the Owner's Representative, to ensure safe and efficient operation and maintenance of electrical systems, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes. Request a meeting with the Owner's Representative prior to substantial completion to coordinate warning requirements.

87.22.08C(1)(g) Danger Signs:

In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations identified by the Owner's Representative as constituting similar dangers for persons in or about project. Request a meeting with the Owner's Representative prior to substantial completion to coordinate danger sign requirements.

1. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
2. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

87.22.08C(1)(h) Equipment/System Identification:

Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2 inch high lettering, on 1-1/2 inch high sign (2 inch high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

1. Electrical cabinets and enclosures.
2. Transformers.

Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panelboards shall be on the inside of the device.

Panelboards, individually mounted circuit breakers, and each breaker in the switchboards, secondary unit substations, and distribution panels shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4 inch high letters.

1. Equipment identification is to indicate the following:
 - b. Equipment ID abbreviation.
 - c. Voltage, phase, wires and frequency.
 - d. Power source origination.
 - e. Example:
 - 1) Panel GLSH1
 - 2) 480/277V, 3 phase, 4 wire
 - 2) Fed by GLSD1
2. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

87.22-09 ELECTRICAL ACCEPTANCE TESTING

87.22.09A General

87.22.09A(1) Description

The work required under this section of the specifications consists of the electrical acceptance testing and inspections for all electrical systems and equipment installed or affected by this project. The Contractor shall prepare and submit to the Engineer for review and approval acceptance test procedures and inspection forms in accordance with this specification. A complete functional acceptance test shall be performed on all electrical systems and equipment to prove they perform as intended under all modes of operation. Testing specified in other sections is in addition to testing specified herein. Also the testing will demonstrate the electrical system and equipment operation to the Owner. All labor, materials, rentals, permits and testing equipment or other which is required shall be provided by the Contractor.

87.22.09A(2) General

The Contractor shall prepare and submit to the Engineer for review and approval acceptance test procedures and inspection forms in accordance with this specification. Testing shall be performed by the Contractor and the manufacturer's representative, depending on the type of equipment or system being tested as follows:

1. CONTRACTOR
 - a. Cables, Low-Voltage, 600-Volt Maximum
 - b. Switches and Circuit Breakers, Air, Low-Voltage
 - c. Lighting System
 - d. Lighting Control System
 - e. Grounding System
 - f. Low Voltage (600 VAC maximum) Power Distribution System
2. MANUFACTURER'S REPRESENTATIVE
 - a. Lighting Control System

The Contractor shall prepare the test procedures and inspection forms and perform the specified testing and inspections, for the assigned equipment and systems above, as applicable to the equipment and systems installed or affected by the project. If the Contractor (including sub contractors) does not have the ability or qualifications to conduct the required tests then the Contractor will sub contract with a testing organization who does.

The Contractor shall engage in and pay for the services of the Manufacturer's Representative approved testing organizations to provide testing and inspection of the applicable electrical equipment and systems as listed above and specified in this section. The testing organizations may be an independent division or authorized representative of the manufacturer of the assembled products being tested. The Manufacturer's Representative will conduct startup testing and will be part of integrated system testing. If an outside testing organization is approved, a representative of the manufacturer shall be under contract by the testing company. The representative shall be present during all testing to insure that the testing is performed properly and that any deficiencies discovered are promptly corrected. The Manufacturer's Representative will assist in the preparation and performance of other test procedures and inspections such as integrated system testing (e.g., loss of power/ generator/ats/ups/annunciator integrated system test)

Submit all test reports to the Owners Representative at least two weeks prior to the project final inspection for review.

87.22.09A(3) SAFETY AND PRECAUTIONS

All parties involved must be cognizant of industry-standard safety procedures. This document does not contain any procedures including specific safety procedures. It is recognized that an overwhelming majority of the tests and inspections recommended in these specifications are potentially hazardous. Individuals performing these tests shall be qualified and capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved.

Safety practices shall include, but are not limited to, the following requirements:

1. All applicable provisions of the Occupational Safety and Health Act, particularly OSHA 29 CFR Part 1910 and 29 CFR Part 1926 including OSHA lockout procedures.
2. ANSI/NFPA 70E, Standard for Electrical Safety in the Workplace.
3. Applicable state and local safety operating procedures.
4. Owner's safety practices.
5. A safety lead person shall be identified prior to the commencement of work.
6. A safety briefing shall be conducted prior to the commencement of work.
7. All tests shall be performed with the apparatus de-energized and grounded except where otherwise specifically required to be ungrounded or energized for certain tests.
8. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

87.22.09A(4) QUALITY ASSURANCE

The testing and inspection shall comply with all applicable sections of the following codes and standards:

1. American National Standards Institute - ANSI
2. American Society for Testing and Materials - ASTM
3. Association of Edison Illuminating Companies - AEIC
4. Institute of Electrical and Electronics Engineers - IEEE
5. Insulated Power Cable Engineers Association - IPCEA
6. International Electrical Testing Association - NETA Acceptance Testing Specifications
7. California Electrical Code - CEC
8. National Electrical Manufacturers Association - NEMA
9. National Fire Protection Association - NFPA

10. State and Local Codes and Ordinances

The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

Review and Approval- All test reports, deficiencies and corrections, test results, shall be reviewed by the Engineer of Record.

87.22.09A(5) Division Of Responsibility

Perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

Supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

Notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

Supply a complete set of electrical plans, specifications, and any pertinent change orders to the testing firm prior to commencement of testing.

Notify the Engineer and Owner's Representative prior to commencement of any testing.

Any system, material or installation which is found defective on the basis of acceptance tests shall be reported to the Owner's Representative.

The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report for review and approval by the Engineer of Record.

87.22.09A(6) Acceptance Test Procedures

The Acceptance Test Procedures shall include the following sections:

1. Purpose of Test
2. References
3. Test Participants- Name/Company/Telephone Number and hand signed Initials
4. Equipment and Systems tested.
5. Description of test.
6. Acceptance Criteria
7. Initial Conditions/Prerequisites
8. Test Equipment and Calibration date
9. Test Procedure and Date of Test
10. Test Results-verification of passing acceptance criteria.
11. Deficiencies, Corrections and Re-test
12. Verification Systems and Equipment are returned to Operational Status
13. Conclusions and recommendations.
14. Appendix, including test forms.

Each piece of equipment shall be recorded in the test procedure listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair or replacement parts. The test procedures shall indicate the name of the engineer who tested the equipment and the date of the test completion.

Inspection Reports may be in situ test reports prepared by manufacturer representatives such as startup test reports by, for example the UPS or Generator manufacturers' startup representative. The inspection reports shall indicate the name of the person who inspected the equipment and the date of completion.

The Acceptance Test Procedure shall be a step by step procedure to be followed verbatim and initialed after each step's performance. The test shall include the listed sections above. The procedure shall be prepared on 8.5" x 11" paper. See Attachment 1 as an example.

87.22.09A(7) Testing Instrument Traceability

All applicable test instrumentation shall be currently calibrated within rated accuracy.

The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field instruments: 6 months maximum.
2. Laboratory instruments: 12 months.
3. Leased specialty equipment: 12 months

Dated calibration labels shall be visible on all test equipment.

87.22.09A(8) Final Settings

The Contractor shall be responsible for implementing all final settings and adjustments of equipment in accordance with manufacturer's and/or Engineer's specified values. The Contractor shall be responsible to request any required setting values from the Engineer.

87.22.09A(9) Submittals

At least two weeks prior to conducting testing, submit Acceptance Test Procedures and Inspection Reports for review and approval by the Electrical Engineer of Record. This includes the prepared test report outlined above including all systems and equipment to be tested (with the test results, deficiencies, and conclusions sections blank). The Contractor shall be responsible to integrate the testing by the Contractor and Manufacturing Representatives. The Manufacturing Representative testing organization shall prepare their regular start up test plan and assist the Contractor in preparing an Integrated System Test. After review and approval the test report shall be executed.

At least two week prior to conduction testing, submit for review and approval by the Engineer the list of test participants and prove of their qualifications and demonstrate they have the necessary testing experience and training to conduct the test.

Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

87.22.09A(10) Failure To Meet Test

Any found defective on the basis of acceptance test shall be reported directly to the Engineer.

Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the Owner.

87.22.09B Products-Not Used

87.22.09C Execution

87.22.09C(1) Equipment To Be Tested and Inspected

The following equipment shall be tested in accordance with the scopes of work which follow and additional participation in other acceptance testing such as integrated system and functional testing. Acceptance test procedures and inspection reports shall be prepared, submitted and approved prior to performance of testing and inspections. The party responsible is identified in accordance with the following key: C = Contractor/Installer; M = Manufacturer; T = Testing Agency.

1. Molded Case Circuit Breakers - C
2. Grounding System - C
3. Cables, Low Voltage, 600 Volts Maximum - C
4. Lighting Control System – C and M

87.22.09C(2) Inspections**87.22.09C(2)(a) Dry Type Transformers**

Visual and Mechanical Inspection:

1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. Torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

87.22.09C(2)(b) Molded Case Circuit Breakers

Visual and Mechanical Inspection:

1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.
3. Verify proper reporting of the events on the project equipment monitoring system

Electrical Tests (400 ampere frame and larger):

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate. Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
 - a. All trip units shall be tested by primary injection.
 - b. Static overcurrent trip devices shall be tested per manufacturer's instructions.
 - c. Test for minimum pick-up current.
 - d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
 - e. Where short time delay characteristics are provided, test short time pick-up and delay.
 - f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
 - g. Where ground fault protection is provided, test ground fault pick-up and delay.
 - h. Check reset characteristics of trip unit.

- i. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

87.22.09C(2)(c) Grounding System

Visual and Mechanical Inspection:

1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes. Inspect a minimum of 5% of project boxes.
2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.

Electrical Tests (Small Systems):

1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.
2. Equipment Grounds:
 - a. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.

Electrical Tests (Large Systems):

1. When sufficient spacing of electrodes described above is impractical, perform ground-impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)
2. Test Values:
 - a. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

87.22.09C(2)(d) Cables - Low-Voltage - 600v Maximum

Visual and Mechanical Inspection:

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color-coding with applicable specifications and National Electrical Code standards.

Electrical Tests:

1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.
3. Test Values:

- a. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
 - b. Provide a test report for each feeder which indicates the manufacturer's target values and actual test reading. Report shall indicate pass/fail for each feeder. Submit report to Owner's Representative for approval. Include test report in project maintenance manual.
4. Cable Values: Cable values shall be established and provided by the cable manufacturer. Provide target value insulation resistance (IR) in megohms, based on 1000 ft. at 60 Deg F.
 5. Temperature Correction Factor: For temperatures above or below 60°F, a correction factor may have to be applied to determine the true IR value. However, if the measured IR of the system is equal to or greater than the calculated value, a correction factor is not needed.
 6. Correct insulation deficiencies which show and insulation resistance of less than one megohm.
 7. Test conductors with power off and impress a voltage of not less than 500 volts D.C.
 8. Perform continuity tests on all conductors.

87.22.09C(2)(e) Lighting Control System

Visual and Mechanical Inspection:

1. Inspect each device for physical damage.
2. Check for proper labeling of conductors.
3. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
4. Check all cabinet doors, latches, and hinges for proper operation. Adjust, lubricate, and repair as required.

Electrical Tests:

1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
2. Meggar test all conductors (other than those intentionally grounded) for isolation from ground.
3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
4. The control unit shall be tested to verify it is in the proper operating condition as detailed in the manufacturer's manual.
5. Each control circuit shall be tested to confirm proper operation of the circuit. Monitor the system with all building equipment energized, such as variable speed controllers, to verify the absence of control inhibiting electrical noise.

87.22-10 LIGHTING CONTROL

87.22.10A General

87.22.10A(1) Summary

This section describes requirements for lighting control equipment.

87.22.10A(2) Reference Standards

The Underwriters Laboratory, Inc. (UL).

National Electrical Manufacturers Association (NEMA).

87.22.10A(3) Quality Assurance

Operational Test:

1. Perform an operational test to assure that the installation complies with all requirements of the Specifications. Tests shall be made in the presence of the Engineer.
2. If any part of the system fails the test, it must be corrected and the test repeated until it satisfactorily passes the test.

Training:

1. Provide manufacturer's system training necessary for the Owner's personnel. The scope of training should include training sequences available at the job site.
2. The number of persons attending the system training courses shall be determined by the Owner's Representative. The training at the job site shall be provided prior to system approval by the Owner's Representative.
3. System operating training shall be given by an experienced and competent manufacturer's representative qualified with the lighting control system. Training shall occur after lighting control install and commissioning.
4. Minimum four (4) hour training on site. Coordinate time and location with Owner. Provide one (1) month notice.

87.22.10B Products

87.22.10B(1) Lighting Control Equipment

Electronic Time Switch

1. Provide 16-circuit electronic time switch of the solid state digital type capable of distributing set points on independent daily schedules throughout a 7 day time period.
2. Provide time switch capable of the following:
 - a. 5 weekday programming, 2 weekend day programming or all 7 day programming to simplify program entry for typical 5/2 day load control.
 - b. Copy feature for duplicating full daily schedules where the 5/2 day scheduling is not applicable.
 - c. Time set points programmable to the nearest minute with a minimum ON duration of 1 minute and a maximum of 6 days, 23 hours and 59 minutes.
 - d. Digital LED readout and prompt LEDs for each function to further simplify program entry.
 - e. For each load control include an ON/OFF pushbutton, an ENABLE/DISABLE switch and an LED load status indicator.
 - f. Operating temperature range of 40° F (40° C) to 122° F (50° C).
 - g. Astronomic programming and momentary or interval programming for any or all circuits independently.
 - h. Astronomic control which automatically calculates center of time zone at times for both sunrise and sunset, and allow user selectable offset of actual times.
 - i. Pulse output programmable for any duration of 1-127 seconds and interval output for up to 6 days, 23 hours and 59 minutes.
 - j. Interval output which provides for user selectable override to turn load(s) on for a limited programmed time period up to 6 days, 23 hours and 59 minutes.
 - k. Full year control by providing automatic leap year and daylight saving time adjustment. Provide user selectable override for states not observing daylight saving time. Provide holiday or special day control requirements by providing up to 99 holiday schedules. Provide holiday schedules programmable for a single day or any duration as required. Provide each holiday schedule with automatic no load activity, independently programmable for a unique load schedule if required.

- l. Provide a non volatile memory to maintain all program data for the life of the time switch without the need for battery backup. Provide the time switch with a factory installed lithium battery backup which shall maintain clock time and calendar data for 8 years minimum. Provide single coin cell backup, user replaceable without removing the field wiring.
 - m. Time switch logic control circuitry, isolated and shielded to prevent EMI and RFI interference, for reliable operation in electrically noisy environments. For the power board circuitry provide protection for transients up to 6,000 volts.
 - n. Provide control times accurate to the minute and synchronized to the 50 or 60 Hz input. Provide user selectable 12 hour AM/PM or 24 hour clock formats.
 - o. Local or remote selection of load override. Remote override shall be initiated by a momentary or maintained switch closure connected to the time switch override connections using bell wire up to 1,000 feet. Provide override terminals to allow independent override selection in addition to independent to the minute override durations for all outputs.
- 4. Enclosure: Lockable steel NEMA 1 enclosure.
- 5. Voltage input: 120 VAC
- 6. Switch configuration: SPDT for each circuit with a UL 916 Energy Management Equipment listed rating of:
 - a. Normally Open Contacts C
 - 1) 20 ampere resistive/general purpose, 12-277 VAC
 - 2) 20 ampere resistive/general purpose, 28 volts DC
 - 3) 20 ampere ballast, 120-277 VAC; 1 HP, 120 VAC 60 Hz; 2HP, 240 VAC 60 Hz
 - 4) 5 ampere tungsten, 120-240 VAC
 - 5) 470 VA pilot duty, 12-240 VAC
 - 6) TV 5, 120-240 VAC
 - b. Normally Closed Contacts C
 - 1) 10 ampere resistive/general purpose, 12-277 VAC
 - 2) 10 ampere resistive/general purpose, 28 volts DC; 3 ampere ballast, 120-277 VAC
 - 3) 120-277 VAC; 1/4 HP, 120 VAC 60 Hz.; 1/2 HP, 240 VAC 60 Hz
 - 4) 275 VA pilot duty, 12-240 VAC
- 2. Manufacturer: Intermatic ET70000CR series, Watt Stopper or equal.

Lighting Contactors:

- 1. Coils: 120 Volt.
- 2. Load Contacts: Totally enclosed, mechanically held silver alloy, rated for designed voltage and amperes, suitable for continuous duty with tungsten, fluorescent or high intensity discharge lamp loads.
- 3. Poles: Number as indicated.
- 4. Provide coil clearing contacts to disconnect coil from control circuit after mechanical latching is accomplished.
- 5. Terminals: Screw pressure-type connections.
- 6. Manufacturer: Square D Class 8903, Westinghouse A202, General Electric CR160L, or equal.

87.22.10C Execution**87.22.10C(1) Lighting Control Equipment**

Mount lighting control equipment in a terminal cabinet, flush on surface as indicated. Mount cabinet so that top is 6 feet 6 inches above finished floor level.

Where access is required for the purpose of manual operation, provide barriers for all live parts.

Identify conductors with circuit numbers and phase color.

Neatly arrange wiring within the equipment. Bundle and wrap conductors with plastic wire ties.

87.22-11 DMX ARCHITECTURAL LIGHTING CONTROL SYSTEM**87.22.11A General****87.22.11A(1) Summary**

This Section includes the requirements for furnishing, installing, and commissioning a complete DMX lighting control system for exterior architectural lighting.

The system shall be capable of controlling dynamic lighting using DMX512, Art-Net, and sACN protocols, with advanced timeline, triggering, and scene management.

Related Sections:

1. Section 87-22.15 – Exterior RGBW Lighting
2. Section 87-22.01 – Common Work Results for Electrical

87.22.11A(2) References

ANSI E1.11 – DMX512-A

ANSI E1.20 – Remote Device Management (RDM) over DMX512 Networks

NEC – National Electrical Code

UL 916 – Energy Management Equipment

FCC Part 15 – Radio Frequency Devices

IEEE 802.3 – Ethernet Standards

ANSI E1.31 – sACN (Streaming ACN5)

87.22.11A(3) Submittals

Product Data:

1. Manufacturer's catalog data, specifications, and installation instructions
2. Control system architecture and wiring diagrams
3. Fixture addressing and DMX universe layouts

Shop Drawings:

1. Riser diagrams and control schematics
2. Control station and processor locations
3. Network topology, DMX line runs, and terminations

Operation and Maintenance Data:

1. Control System Programming Documentation

87.22.11A(4) Quality Assurance

Manufacturer Qualifications: Minimum 5 years' experience in DMX lighting control systems

Installer Qualifications: Certified installer by control system manufacturer

Comply with all applicable local codes and ordinances

87.22.11A(5) Warranty

Provide minimum 5-year manufacturer warranty for all control system components

87.22.11B Products**87.22.11B(1) Acceptable Manufacturers**

Pharos Architectural Controls Ltd.

87.22.11B(2) System Description

System shall consist of the following components:

1. DMX512-A controllers and processors
2. DMX gateways, splitters, repeaters, isolators, and ethernet nodes
3. Wall-mounted control station (touchscreen)
4. Remote Device Management (RDM)-enabled devices
5. Power supplies and required interfaces
6. Control software with graphical interface and scheduling features

The system shall be capable of controlling all DMX-addressable luminaires and devices, either directly or via gateways.

System shall support:

1. Multiple DMX universes
2. Preset recall, scene transitions, and time-of-day scheduling
3. Integration with building management systems (via BACnet/IP, sACN, or Art-Net), if required.

The system shall be furnished by the manufacturer of the RGBW luminaires for proper coordination with exterior RGBW lighting.

87.22.11B(3) Controllers And Interfaces**87.22.11B(3)(a) General**

The Controller shall be a microprocessor-based system specifically designed for control of lighting in an architectural or entertainment application. A personal computer running emulation software shall not be acceptable.

The Controller shall store operating software and show data in non-volatile solid-state memory with capacity at least 128GB.

The Controller shall have one dedicated Ethernet port for remote management and one dedicated Ethernet port for outputting control data.

Show data may be downloaded from a remote personal computer over an Ethernet connection to the management port.

It shall be possible to update the Operating Software by download from a remote personal computer over an Ethernet connection to the management port.

The Controller shall commence show playback automatically on receiving power without additional external inputs.

The Controller shall have an internal real-time clock that continues to operate when external power is absent. It shall be capable of adjusting for Daylight Savings Time automatically and can be updated using the Network Time Protocol (NTP) over an Internet connection to the management port.

The Controller shall be able to calculate sunrise, sunset, dawn and dusk times based on longitude and latitude information, and use these as triggers for events.

The Controller shall be able to calculate phases of the moon and use these as triggers or conditionals for events.

The capacity of the controller shall be defined in terms of number of control channels being used, and the maximum capacity of each unit shall be factory-configured to user requirements.

The Controller shall be able to output control data as Art-Net I, Art-Net II, Art-Net 3, KiNET, sACN and Pathport protocols simultaneously via Ethernet on the data port.

There shall be visual indicators on the Controller showing status of the controller and its interfaces.

The Controller shall operate a web server on its management Ethernet interface. This shall allow status information, control and configuration options to be remotely accessed within a secure, private network.

The appearance and content of the web interface may be customized by the user.

The Controller shall allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.

The Controller shall support multiple timelines, scenes, crossfades and effects running concurrently.

The Controller shall support playback of video media with individual pixels mapped to lighting fixtures in an array.

The Controller shall support a full-duplex RS232 Serial Port for interfacing to show control devices with port settings and syntax freely configurable.

The Controller shall be capable of receiving Art-Net II, sACN or arbitrary TCP/UDP data over Ethernet to its management port for triggering.

The Controller shall be capable of receiving a live video input via an optional HDMI capture port and mapping individual pixels to lighting fixtures in an array.

The Controller shall be capable of outputting audio input via SPDIF or via stereo balanced line level analog audio outputs.

The Controller shall support two linear timecode buses via its stereo balanced line level analog audio inputs.

The Controller shall support multiple remote devices connected via Ethernet to its management port for support of touch stations, buttons stations and additional show control interfaces, such as contact closures, analog inputs, relay outputs, serial, audio input, additional linear timecode, MIDI and DALI.

The Controller shall support multiple streams of timecode and audio data within a single networked system.

The Controller shall have a recessed switch for resetting the unit without removal of power.

The Controller shall have an internal watchdog feature that will restart the unit in the event of program failure.

The Controllers can be linked to other Controllers via Ethernet to its management port when programmed as part of a single show and shall automatically synchronise and share triggers during playback.

The Controller shall support conditional logic and execute user-defined Lua scripts to support advanced show control operations.

The Controller shall be provided with a 5 year manufacturer warranty.

87.22.11B(3)(b) Physical

Enclosure and mounting shall comply with IEC 60297

The unit shall be a 1U 19" rack mount enclosure (19" x 1.75" x 13.5")

The unit shall have solid-state electronics and storage.

The unit shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

The unit shall be CE and UKCA compliant.

The unit shall be ETL/cETL listed.

87.22.11B(3)(c) Electrical

The Controller shall be designed to support the following standard connectors:

Neutrik etherCON socket (RJ45 compatible) for 10/100/1000 Base-TX Ethernet for control data

Neutrik etherCON socket (RJ45 compatible) for 10/100/1000 Base-TX Ethernet for system management

(2) USB-A Socket for USB 2.0

(Optional) HDMI socket for HDMI video capture

RCA socket for SPDIF digital audio output

DisplayPort socket for video output for monitoring or video mapped fixtures

IEC socket for 100-240VAC/50-60Hz/0.4-0.2A mains input with switch.

The Controller shall be designed to support the following wire terminations (Camden Electronics CTB9208 5.08mm plug-in rising clamp terminals):

6-pin Stereo balanced line level analog output port

6-pin Stereo balanced line level analog input port

3-pin RS232 serial input/output and the plug-in rising clamp terminals shall be provided.

87.22.11B(3)(d) User Interfaces:

Touchscreens with graphical interface

Mobile device control

87.22.11B(4) Dmx Infrastructure

Wiring:

1. Use DMX-approved, shielded twisted-pair cable
2. Cable shall meet or exceed ANSI E1.11 standards
3. Maximum DMX run length per universe: 1,200 ft (without repeater)
4. Use CAT6 or higher-rated shielded twisted pair cable for all Ethernet communication
5. Power over Ethernet (PoE) per IEEE 802.3af or as required by Pharos device

Signal Distribution & Network Integration:

1. DMX splitters and repeaters shall be optically isolated
2. Termination resistors shall be installed at end of each DMX run

3. Ethernet Data Nodes ("Node") shall be a solid-state device specifically designed to be part of a lighting control system in an architectural or entertainment application.

The Node shall operate in conjunction with a compatible lighting controller ("Controller") that it communicates with over an Ethernet network.

The Node shall receive data from a Controller and output it as DMX512 based on a user-configurable mapping (patch).

The Operating Software of the Node shall be stored in a dedicated non-removable non-volatile solid-state memory. It shall be possible to update the Operating Software by download from a remote personal computer over an Ethernet connection.

The Node shall automatically connect to a Controller over an Ethernet connection on receiving power without additional external inputs.

The Node shall have two (2) Ethernet ports – one for connection to a Controller via an Ethernet network and one to allow optional additional Nodes to be daisy-chained.

There shall be visual indicators on the Node showing status of the device and its ports.

The Node shall provide twenty (20) DMX512 ports.

The DMX512 ports shall have surge protection and be capable of restoring output automatically once an external fault condition is cleared.

The Node shall support the Remote Device Management protocol (ANSI E1.20) on each DMX512 port.

The Node shall support up to 20 Serial Data Interfaces (SDI) for optional output of synchronous and asynchronous serial data

The Node shall receive data from a Controller and in SDI Mode output it as serial data based on a user-selectable protocol and patch.

The Node shall have an address wheel to aid simple addressing of up to 15 devices, with an additional setting that allows addressing to be configured via software.

Up to 200 Nodes shall be addressable and able to operate together within a system.

The Node shall have a recessed switch for resetting the unit without removal of power.

The Node shall have an internal watchdog feature that will restart the unit in the event of program failure.

The Node shall be provided with a 5 year manufacturer warranty.

87.22.11B(4)(a) Physical

Enclosure and mounting shall comply with IEC 60297

The Node shall be a 1U 19" rack mount enclosure (19" x 1.75" x 7.2")

The Node shall use solid-state electronics and memory.

The Node shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

The Node shall be rated IP40

The Node shall be CE compliant.

The Node shall be ETL/cETL listed.

87.22.11B(4)(b) Electrical

The Node shall be designed to support the following wire terminations (0.200" (5.08mm) plug-in rising clamp terminals):

3-pin isolated DMX512 Out, RDM-compatible (20)

and the plug-in rising clamp terminals shall be provided.

In addition the Node shall have the following standard connectors:

Neutrik etherCON socket (RJ45 compatible) for 100/1000Base-TX Ethernet (2)

IEC socket for 100-240VAC/50-60Hz/0.4-0.2A mains input.

The DMX512 ports shall be independently galvanically isolated up to 2kV

The DMX512 ports shall be able to withstand continuous AC voltage up to 300V

The DMX512 ports shall be able to withstand peak impulse voltage up to 650V with duration less than 10ms

87.22.11B(4)(c) Software

The Node and associated Controller shall be supported by programming software running on either a PC or Mac platform.

87.22.11B(4)(d) Product

The Node shall be the Pharos EDN20 from Pharos Architectural Controls Ltd.

87.22.11B(5) Software

Configuration software shall allow for:

1. Full system configuration, fixture patching, effect creation, and show control logic
2. Scene and preset programming
3. Scheduling and time-based events
4. Remote configuration
5. Remote monitoring and diagnostics

87.22.11C Execution

87.22.11C(1) Examination

Verify field conditions are suitable for installation

1. Prepare installation location. Location shall be compliant with environmental specifications.
2. Confirm coordination with lighting fixtures and other control systems
3. Open and unpackage products per manufacturer's instructions at scheduled time of installation.
4. Review unpackaged products for damage and replace damaged products.

87.22.11C(2) Installation

Install control devices per manufacturer's instructions and approved submittals

Maintain proper DMX cabling practices (e.g., daisy-chaining, termination, shielding)

Label all cables, terminations, and control stations clearly

Ensure proper segregation of control and power wiring

Ensure all DMX system components are installed in an indoor environment or with proper NEMA rated enclosures and readily accessible for servicing.

Provide time and fee for manufacturer-trained technician to attend the following lighting control meetings:

1. Pre-installation meeting with representative of Owner, General Contractor, Bridge Aesthetic Lighting system contractor, Tele-data contractor, Manufacturer's Representative, Architect, and Electrical Engineer
2. Pre-programming meeting with representative of Owner, General Contractor, Bridge Aesthetic Lighting system contractor, Tele-data contractor, Manufacturer's Representative, Architect, and Electrical Engineer

3. After-hours Aim and Focus meeting upon system completion with representative of Owner, General Contractor, Bridge Aesthetic Lighting system contractor, Architect, Manufacturer's Representative, and Bridge Aesthetic Lighting system Engineer

87.22.11C(3) Field Quality Control

Perform point-to-point verification of all DMX runs

Test communication to all devices

Verify scene functionality, transitions, and interface operation

Provide product replacement for malfunctioning or damaged products.

Install malfunctioning or damaged product replacement.

Commission product replacement.

87.22.11C(4) Commissioning

Engage local manufacturer-trained technician to program and commission system per contract documents and owner provided sequence of operations.

Schedule system startup with manufacturer certified technician at least 3 weeks prior to the site being ready.

Provide technician startup time.

Ensure system is fully installed, tested, and functional prior to startup.

Demonstrate full operation to Owner, Architect, and Bridge Aesthetic Lighting system Engineer

Provide 4-hour training to owner for system operation and maintenance

Provide (1) on-site visit scheduled 6-12 months after completion to:

1. Review system with Owner
2. Make programming adjustments as needed
3. Provide additional on-site training to owner

87.22.11C(5) Cleaning and Protection

Clean installed devices and surfaces of construction debris

Protect installed control stations and touchscreens until final acceptance

87.22.11C(6) CLOSEOUT

Verify programming with control intent documentation

Provide closeout documents:

1. Final programming files for local storage and cloud backup
2. O&M manuals with troubleshooting guide, installation instructions, and contact info for support
3. Approved Submittals
4. As-built drawings

87.22-12 LOW-VOLTAGE TRANSFORMERS**87.22.12A General****87.22.12A(1) Summary**

This section describes requirements for dry type transformers.

87.22.12A(2) Reference Standards

The Underwriters Laboratory, Inc. (UL).

National Electrical Manufacturers Association (NEMA).

87.22.12A(3) Qualifications

The equipment manufacturer shall be ISO 9000, 9001 or 9002 certified.

The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

The transformers shall be suitable for and certified to meet all applicable seismic requirements of the International Building Code (IBC) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the transformer manufacturer and be based upon testing of representative equipment.

The test response spectrum shall be based upon a 5 percent minimum damping factor, IBC: a peak of 0.75g, and a ZPA (zero period acceleration) of 0.38g. The tests shall fully envelope this response spectrum for all equipment natural frequencies up to at least 35Hz.

87.22.12A(4) Submittals

Submit manufacturers' data and shop drawings in accordance with the Contract's General Conditions.

Manufacturers Data:

1. Dimension drawing and weight.
2. Technical certification sheet.
3. Conduit entry/exit locations.
4. Transformer ratings including:
 - a. Primary and secondary kVA.
 - b. Voltage.
 - c. Taps.
 - d. Primary and secondary continuous current.
 - e. Basic Impulse level for equipment over 600-volts.
 - f. Impedance.
 - g. Insulation class and temperature rise.
 - h. Sound level.

87.22.12B Products**87.22.12B(1) Transformers - General Requirements**

Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet (1,000 m).
2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).
 - b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).
3. Ambient Temperature: Not exceeding 86 degrees F (30 degrees C) average or 104 degrees F (40 degrees C) maximum measured during any 24-hour period.

Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

Basic Impulse Level: 10 kV.

Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

Isolate core and coil from enclosure using vibration-absorbing mounts.

Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

87.22.12B(2) Dry Type Power Transformers

General: Provide dry type power transformers, for lighting and general power applications, rated as indicated.

Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, yearly operation, with normal life expectancy as defined in American National Standards Institute (ANSI) C57.96.

Shipping: Provide lifting holes, accessible without removal of any of the enclosure components.

Insulation, as listed:

Insulation Size	Temperature Class	Rating	Hot Spot Allowance
2kVA & below	30 degrees C	NEMA B or better	80 degrees C rise
3kVA thru 15kVA	30 degrees C	NEMA F or better	115 degrees C rise
15kVA and above	30 degrees C	NEMA H	150 degrees C rise

Base temperature rating and hot spot allowances in the above table on a 40 degrees C maximum ambient temperature and 30 degrees C average ambient temperature.

Overload Capacity: 10 percent above full load rating continuously in an ambient not exceeding 40 degrees C.

Case Temperature: Maintain no more than a 35 degrees C rise above a 40 degrees C ambient.

Taps, as listed:

Transformer Rating	Phase	Taps
Through 10kVA	Single	None
15kVA thru 25kVA	Single	(2) 5 percent FCBN
6kVA thru 15kVA	Three	(2) 5 percent FCBN

30kVA and larger	Single and Three	(2) 2-1/2 percent FCAN and (4) 2-1/2 percent FCBN where FCBN – Full Capacity Below Normal

Sound levels, not to exceed listed values, as determined by NEMA standards:

Size	Sound Level in dB
Through 9kVA	40
10 through 50kVA	45
51 through 150kVA	50
151 through 300kVA	55
301 through 500kVA	60
501 through 700kVA	62
701 through 1000kVA	64

Provide vibration isolating mounts to isolate the enclosure from the core and coil assembly.

Mounting, suitable as listed:

1. Single Phase Transformers: Wall
2. Three Phase Transformers, through 15kVA: Wall.
3. Three Phase Transformers, 15kVA and above: Floor or ceiling hung channel.

Provide conduit knockouts for line and load conduit entrance.

Enclosure:

1. Units rated 30kVA and below, the encapsulated enclosure construction shall be totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
2. Units rated 15kVA and above, the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt.
3. Outdoor units rated 15kVA or above, provide suitable weather-shields over ventilation openings.

Finish: Degrease, clean, phosphatize, prime and finish all interior and exterior surfaces with baked enamel, color ANSI 61 or standard factory grey.

Connect a grounding strap from the secondary neutral to a grounding lug on the enclosure.

Subject transformers 25kVA above to listed production test at factory:

1. Ratio tests at the rated voltage connection and at all tap connections.
2. Polarity and phase relation tests on the rated voltage connection.
3. Applied potential tests.
4. Induced potential test.
5. No-load and excitation current at rated voltage on the rated voltage connection.

Factory to perform the listed standard tests on unit of identical design:

1. No-load losses.
2. Total losses.
3. Sound levels.
4. Temperature rise.

5. Impulse.
6. Impedance.
7. Induced potential.
8. Applied potential.

87.22.12C Execution**87.22.12C(1) Dry Type Power Transformer**

Mount transformer on floor or wall as indicated.

Provide one (1) vibration isolating mount, minimum 1 inch thick with 1 inch static deflection, for each mounting point on the transformer.

Connect transformer with flexible metal conduit. Provide an insulated grounding bushing on conduit and bond to transformer case.

87.22-13 PANELBOARDS**87.22.13A General****87.22.13A(1) Summary**

This section describes requirements for branch circuit panelboards included in the bridge aesthetic lighting system scope of work.

87.22.13A(2) Reference Standards

The Underwriters Laboratory, Inc. (UL).

National Electrical Manufacturers Association (NEMA).

87.22.13B Products**87.22.13B(1) Panelboards - General Requirements**

Provide products listed, classified, and labeled as suitable for the purpose intended.

Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).
2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
 - b. Panelboards Containing Fusible Switches: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

Conductor Terminations: Suitable for use with the conductors to be installed.

Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

87.22.13B(2) Branch Circuit Panelboards

General: Provide bussed, circuit breaker type panelboards with main lugs or circuit breaker in flush or surface mounted enclosures as indicated.

Construction:

1. Cabinets: Code gauge steel cabinets, deadfront panels, and doors. Fasten deadfront panels to cabinets with concealed trim fasteners. Conceal front door hinges.
2. Dimensions: 20 inches wide by 6 inches deep.
3. Locks: Flush door locks, keyed alike for all panelboards.
4. Access: Door-in-Door (Not EZ-Trim).
5. Standards: Provide UL label where applicable and conform to No. 67 and 50 Underwriters Laboratories, Inc., and NEMA PB-1.

Bussing:

1. Phase Bus: Silver-plated copper, rated 1000 amperes per square inch cross sectional area maximum, braced for 100,000 rms amperes minimum.
2. Neutral Bus: Copper with lugs for connection of neutral conductors.
3. Ground Bus: Copper with terminals for equipment grounding conductors.
4. Terminals: As specified in Section 87-22.03 – Low-Voltage Electrical Power Conductors and Cables.

Finish: Degrease, clean, phosphatize, prime, and finish cabinets, deadfront panels, and doors with baked enamel, color ASA-61, or standard factory grey. Galvanized cabinets are acceptable for flush cabinets.

Nameplates:

1. Provide a nameplate identifying panelboard in accordance with 87-22.08 - Identification for Electrical Systems.

2. Provide a manufacturer's nameplate on the deadfront interior panel indicating panelboard type, voltage rating, current rating and manufacturer's name.

Directory: Provide a directory card which fits into slots in the back of the panelboard. Protect directory with non-yellowing clear plastic.

Manufacturer: Westinghouse (Pow-R-Line 2), General Electric, Square D.

Circuit Breakers:

1. Provide circuit breakers for miscellaneous branch circuits with frame sizes and ratings as shown on the plans.
2. Bolt-on, thermal magnetic, molded case, with inverse time current overload, and instantaneous magnetic trips, trip-free and trip-indicating all poles of multi-pole device shall operate simultaneously during open, close and trip operations. Provide circuit breakers indicated with the following ratings:

Panel Type	Circuit Breaker Frame Size	Trip Rating (Amperes)	Voltage (Ac Rating)	Symmetrical AC Interrupting Capacity
1	100/1 pole	15-100	120	10,000 Min
	100/2 & 3 poles	15 – 100	240	10,000 Min
	150/2 & 3 poles	110 - 150	240	18,000 Min
	225/3 poles	125 - 225	240	22,000 Min

Panel Type	Circuit Breaker Frame Size	Trip Rating (Amperes)	Voltage (Ac Rating)	Symmetrical AC Interrupting Capacity
2	100/1 pole	15-100	277	14,000 Min
	100/2 & 3 poles	15 – 100	480	14,000 Min
	150/2 & 3 poles	110 - 150	480	25,000 Min
	225/3 poles	125 - 225	480	25,000 Min

Manufacturer: Eaton Cutler-Hammer (Pow-R-Line 2), General Electric, Square D.

87.22.13C Execution

87.22.13C(1) Branch Circuit Panelboards

Mount panelboard so that the top is 6 feet-6 inches above the finished floor.

Neatly terminate conductors onto breaker, ground bus and neutral bus. Train conductors in an organized grouping with conductors fanning out at the circuit terminals, bundled in the wireways and laced with plastic ties.

Identify all conductors with a circuit number and phase color.

Type all panelboard directories.

Provide insulated grounding bushings on all conduits which enter the cabinet and bond to ground bus.

Install conduits in a vertical line, perpendicular to the cabinet.

87.22-14 87.22.14 EXTERIOR LIGHTING

87.22.14A General

87.22.14A(1) Section Includes

Exterior luminaires.

LED lamps and drivers.

Poles and accessories.

87.22.14A(2) Related Requirements

Section 87-22.07 - Boxes for Electrical Systems.

87.22.14A(3) Reference Standards

IES RP-8 - Roadway Lighting; 2014.

NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

UL 1598 - Luminaires; Current Edition, Including All Revisions.

87.22.14A(4) Submittals

Provide submittals for items listed documenting compliance with the Contract's General Conditions.

Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.

Test Reports: Indicate measured illumination levels.

Manufacturer's 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.

Operation and Maintenance Data: Instructions for each product including information on replacement parts.

87.22.14A(5) Quality Assurance

Conform to requirements of NFPA 70.

Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

87.22.14A(6) Delivery, Storage, And Handling

Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

Keep products in original manufacturer's packaging and protect from damage until ready for installation.

Store in a dry location until installed and handle with care not to damage finish. maintain in manufacturer's package material until installation.

87.22.14A(7) Coordination

Furnish bolt templates and pole mounting accessories to installer of pole foundations.

87.22.14A(8) Extra Materials

See the contract General Conditions.

87.22.14B Products**87.22.14B(1) Luminaires And Poles**

Furnish products as indicated in luminaire Schedule.

87.22.14B(2) Luminaires

Provide products that comply with requirements of NFPA 70.

Provide products that are listed and labeled as complying with UL 1598, where applicable.

Provide products listed, classified, and labeled as suitable for the purpose intended.

Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

87.22.14B(3) Poles

Manufacturers: as indicated in the luminaire schedule

All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.

87.22.14B(4) LED Luminaires:

Components: UL 8750 recognized or listed as applicable.

Tested in accordance with IES LM-79 and IES LM-80.

LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

75CRI minimum outdoor lighting, 90 CRI minimum indoor.

Kelvin temperature as specified.

87.22.14C Execution**87.22.14C(1) Installation**

Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.

Perform work in accordance with NECA 1 (general workmanship).

Install products in accordance with manufacturer's instructions.

Install luminaires in accordance with NECA/IESNA 501.

Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

Install accessories furnished with each luminaire.

Bond products and metal accessories to branch circuit equipment grounding conductor.

Install poles plumb.

1. Provide double nuts to adjust plumb.
2. Grout around each base provide sack finish on exposed concrete bases above ground.

Install lamps in each luminaire.

Bond luminaires, metal accessories, and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

87.22.14C(2) Field Quality Control

Inspect each product for damage and defects.

Operate each luminaire after installation and connection to verify proper operation.

Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

87.22.14C(3) Adjusting

Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

Aim and adjust luminaires to provide illumination levels and distribution indicated on Drawings.

87.22.14C(4) Cleaning

Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

Clean electrical parts to remove conductive and deleterious materials.

Remove dirt and debris from enclosure.

Clean photometric control surfaces as recommended by manufacturer.

Clean finishes and touch up damage.

87.22-15 EXTERIOR RGBW LED LIGHTING (SSL)

87.22.15A General

87.22.15A(1) Summary

Work under this section includes the furnishing and installation of exterior-rated RGBW LED luminaires for Bridge Aesthetic Lighting.

The system shall provide dynamic color-changing illumination using RGBW LED technology, and shall interface with a lighting control system via DMX, DALI, or 0-10V dimming protocols.

Related Sections:

1. Section 87-22.11 – DMX Lighting Controls (e.g., Pharos)
2. Section 87-22.14 – Exterior Lighting

87.22.15A(2) References

UL 8750 – Standard for LED Equipment in Lighting Products

UL 1598 – Luminaires, Including Wet Location Listings

ANSI C78.377 – Chromaticity of Solid State Lighting

IES LM-80 – Lumen Maintenance of LED Light Sources

IEC 60529 – Ingress Protection (IP) Ratings

IES TM-30 – Method for Evaluating Light Source Color Rendition

87.22.15A(3) Submittals**87.22.15A(3)(a) Product Data**

Submit manufacturer's technical data sheets for each luminaire type, including:

1. Wattage, lumen output, beam angles, and RGBW configuration
2. Photometric reports (IES files)
3. Ingress protection rating and environmental temperature ranges
4. Control protocol and driver compatibility

87.22.15A(3)(b) Shop Drawings:

1. Fixture mounting details and dimensions
2. Wiring diagrams and control connections
3. Fixture layout plan with DMX addresses (if applicable)

87.22.15A(3)(c) Photometrics

1. Point-by-Point plan showing calculated foot candle levels at the river's stated water level, approximately 20'-0" from bottom of bridge.
2. Maximum acceptable foot candle level is 0.05 footcandles.

87.22.15A(3)(d) Warranty Documentation**87.22.15A(3)(e) Operations and Maintenance Manuals****87.22.15A(4) Quality Assurance****87.22.15A(4)(a) Manufacturer:**

SSL (Solid State Luminaires) or Engineer-approved equal

Minimum 10 years of experience in manufacturing exterior-rated RGBW LED luminaires

87.22.15A(4)(b) Installer Qualifications

Licensed electrical contractor with experience installing exterior-rated LED systems

87.22.15A(5) Warranty

SSL shall provide a 5-year limited warranty covering complete luminaires, including LED boards, drivers, and finish.

Warranty shall include protection against color shifting, driver failure, and finish corrosion due to outdoor exposure.

87.22.15B Products**87.22.15B(1) Manufacturer**

Solid State Luminaires (SSL)

Website: <https://www.solidstateluminaires.com>

Representative: Traci Godbey, Associated Lighting Reps., Inc., www.alrinc.com

Basis of Design Products (examples, customize per project):

- CLZWET-RGBW: Compact linear grazing luminaire
- CLZF-RGBW: High Candela, multi-module RGBW projector fixture
- CLZMF-RGBW: Compact, high-output RGBW projector fixture

87.22.15B(2) RGBW Exterior Luminaires**87.22.15B(2)(a) General Characteristics:**

1. LED configuration: RGBW (Quad Chip red, green, blue, and white LEDs)
2. White channel CCT: 3000K or 4000K (specify)
3. Beam angles: [narrow / medium / wide / elliptical / grazing]
4. Operating temperature: -40°F to 122°F (-40°C to 50°C)
5. Luminaire LEDs with Robotic calibration of X-Y chromaticity coordinates to maintain 1 SDCM color consistency
6. Fixtures to provide maximum output power to LEDs with any color combination to provide maximum color saturation.

87.22.15B(2)(b) Housing & Construction:

1. Material: Anodized Extruded Aluminum Housing with Injection Molded Endcaps
2. Finish: Marine-grade powder coat – Silver standard, black, white, or RAL available
3. Ingress Protection: Must meet or exceed IP66, suitable for wet locations
4. Lens: Clear, UV-stabilized polycarbonate or low iron-tempered glass
5. Vibration Resistance : Must meet or exceed 3G ANSI C136.31
6. Lens impact rating; Must meet or exceed IK08
7. Connectors and Cabling : IP68 rated, Twisted Pair Shielded DMX for ground continuity

87.22.15B(2)(c) Electrical Performance:

1. Voltage: 120-277VAC
2. Power: Not to exceed 10W/ft
3. Dimming/Control Options:
 - a. DMX512-A (standard for color control)
 - b. RDM ANSI E1.20 (for remote device management)
 - c. Optional DALI or 0-10V interface (for fixed white or zone color control)
 - d. Firmware to provide 16-bit dimming curve using only 8-bit of DMX addressing space for smooth

performance achieving < 3% flicker

87.22.15B(2)(d) Optical Performance:

1. Color rendering index (CRI): 80+
2. Lumen output: Must meet or exceed 450lm/ft ALL ON – Efficiency not be below 45lm/w on average.
3. 4-in-1 LEDs to provide instantaneous color mixing directly within the collimating chamber of optic

87.22.15B(2)(e) Mounting Options:

1. Slim Adjustable surface brackets up to 90 degree adjustability
2. Ground-recessed or pole-mounted accessories as needed

87.22.15B(2)(f) Accessories:

1. Slim Adjustable surface brackets up to 90 degree adjustability
2. Jumper cables and terminations
3. Control interfaces and addressing tools

87.22.15B(3) Drivers and Power/Data Wiring Boxes

Fixtures include integral Class II, electronic 99% power factor Power supply

Wiring boxes must include 22kV Surge protection with 7A time delay fuse

Fixtures to include overheating thermal protection

Enclosures to meet NEMA 4X or IP66 minimum rating

Enclosures must include DIN Rail mounted Terminal blocks for landing wiring

Enclosures must include ability to have tamper resistant locking for safety

87.22.15C Execution

87.22.15C(1) Examination

Verify mounting substrates are suitable for fixture installation

Ensure power and control rough-ins are complete and tested

87.22.15C(2) Installation

Install fixtures per manufacturer installation instructions and approved submittals

Manufacturer to provide lighting layout and connectivity diagram

Use corrosion-resistant fasteners and waterproof cable seals

Terminate all DMX/data wiring per ANSI E1.11 standards, with proper shielding and termination

Fixtures to include auto-addressing feature for RDM configuration.

87.22.15C(3) System Startup and Testing

Confirm fixture addressing and functionality with control system

Verify uniform color mixing and dimming response across all fixtures

Perform DMX line testing and RDM discovery (if applicable)

On-Site Startup, Testing and Commissioning Services to be provided.

87.22.15C(4) Cleaning and Protection

Clean lenses and housing of construction debris

Protect luminaires from damage until final project turnover

87.22.15C(5) Closeout

Submit as-built layout with final DMX addresses and control zones

Provide Manufacturer O&M manuals and warranty documents

Provide digital backup of configuration files and driver settings

Add section 87-23:**87-23 TRAFFIC WARNING GATE****87-23.01 GENERAL****87-23.01A Summary**

Traffic Warning Gate includes furnishing the units to the job site ready to incorporate into the work, installing foundations as necessary, and erecting the members into the final position in the work.

Concrete must comply with section 51.

Reinforcement must comply with section 52.

87-23.01B Definitions

Not Used

87-23.01C Submittals**87-23.01C(1) General**

For traffic warning gates submit an installation work plan. The work plan must include procedures, details and sequences for:

1. Unloading
2. Lifting
3. Installing

The work plan must detail how the installation of the warning gate will interface with the installation of the precast concrete traffic warning gate monument.

Allow 10 days for review.

87-23.01C(2) Shop Drawings

Submit shop drawings for the traffic warning gates. Shop drawings must include:

1. Plan, elevation, and section views of the gates, housings, roadway, sidewalks, curbs, bridge deck, foundations and other related features at each warning gate location.
2. Critical dimensions of all elements.
3. Locations of lights, bells/gongs, counterweights, anchorage devices, and other necessary features.
4. Details illustrating that the traffic warning gate will fit within the precast traffic warning gate monument.
5. Schematic wiring diagrams of gate housing internal wiring. Coordinate wiring requirements with the bridge Control System Vendor (CSV).
6. Drawings, details, and calculations for the foundations and anchorages for the traffic warning gate monument located off of the bridge structure. This item is to be coordinated with the Precast Concrete Traffic Warning Gate Monument foundations and connections to ensure that there are no conflicts between the two elements.

Include the manufacturer's operation and maintenance manuals for new rotary cam limit switches, traffic warning gates, packaged engine generators, transfer switches, VFDs, and PLC monitoring equipment.

Submit 7 copies of the shop drawings. Allow 25 days for review. Upon authorization, the Engineer returns 2 copies to you for use during construction.

87-23.01C(3) Certificate of Compliance

Submit a certificate of compliance signed by the supplier's QC representative for the traffic warning gates for each shipment.

87-23.02 MATERIALS

87-23.02A General

Provide traffic gates as completed assemblies including the components listed below.

1. Gate Arm: UV-resistant fiberglass or aluminum arm, mounted to a wishbone base with counterweights.
 - a. Both Faces: Reflective 16" alternating vertical red and white striping meeting the MUTCD.
 - b. Lights: DOT/SAE 4-inch, two-way red LEDs as indicated on the plans.
 - c. Provide 120V:12V transformer and flasher.
 - d. Length and Offsets: as indicated on the plans.
 - e. Mounting Flange: Provide with a breakaway feature to ensure a clean break if arm is struck by vehicle.
2. Arm Base: Sacrificial shear pin to allow arm to break away and swing from 60 to 80 degrees. At full open position, arm is prevented from swinging into traffic via a spring-loaded latch with manual reset.
3. Arm Channels: Hot-dipped galvanized steel channels connecting the gate arm and counterweights to the operator.
 - a. Counterweights: Galvanized steel.
 - b. Finish: Baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
4. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; dimensions as shown on the plans. Provide front and rear, gasketed access doors for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from the inside of the cabinet. Cabinets must be waterproof.
 - a. Sheet metal used to fabricate the cabinets must meet UL 325 requirements.
 - b. Finish: Baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
 - c. Internal arrangement of equipment in the cabinet shall be such that all equipment is accessible via the reach access door.
5. Operator: Instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through the speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.
 - a. Motor Size: Sized according to arm length
 - b. Voltage: 460VAC.
 - c. Phase(s): Three
 - d. Hertz: 60
 - e. Operating Time: Eight Seconds
 - f. Limit Switches: Eight circuit limit switch
 - g. Inherently adjustable, torque limiting clutch for safety
 - h. Hand crank for manual operation
 - i. Electrical disconnect
6. Limit Switch: The gate limit switch assembly must be a self-contained unit. The assembly must provide 8 independent Single-Pole Double-Throw (SPDT) control switches. The switches must be rated for 15 amps at 480 VAC. Switches must be controlled by individually adjustable cams. The limit switch assembly design shall permit adjustment of all cams with the gate in any position. The limit switch assembly must have a

removeable cover to help prevent accidental contact with switch terminals. Shafts, cams, bushings, and house pieces must be non-ferrous corrosion resistant materials.

7. Anchor bolts and hardware to be furnished by the manufacturer.

8. Vibrating bell/gong must be a heavy-duty motor driven industrial quality warning bell. The gear train must be able to drive a cam and hammer to strike the gong shell approximately 100 blows per minute.

87-23.03 Construction

Make adjustments to oncoming and offgoing gate arms so that they are level with each other and perpendicular from the crown of the roadway in the down position.

Balance all gate arms to ensure arms operate smoothly and reach proper lowered and raised positions.

Make adjustments to barrier gates so that arm fits properly into the arm receiver when lowered.

87-23.04 Payment

Not Used

Add section 87-24:

87-24 PEDESTRIAN WARNING GATE

87-24.01 GENERAL

87-24.01A Summary

Pedestrian Warning Gate includes furnishing the units to the job site ready to incorporate into the work and erecting the members into the final position in the work.

87-24.01B Definitions

Not Used

87-24.01C Submittals

87-24.01C(1) General

For pedestrian warning gates submit an installation work plan. The work plan must include procedures, details and sequences for:

1. Unloading
2. Lifting
3. Installing

The work plan must detail how the installation of the warning gate will interface with the Type 85 to ST-75 barrier transition details.

Allow 10 days for review.

87-24.01C(2) Shop Drawings

Submit shop drawings for the pedestrian warning gates. Shop drawings must include:

1. Plan, elevation, and section views of the gates, housings, sidewalks, bridge deck, and related features at each warning gate location.
2. Dimensions of all elements.
3. Locations of pivot points, anchorage devices including how they will interface with the bridge deck, and other necessary features.
4. Details illustrating that the traffic warning gate will fit within the space provided in the Type 85 to ST-75 barrier transition.
5. Schematic wiring diagrams of gate housing internal wiring. Coordinate wiring requirements with the bridge Control System Vendor (CSV).

Include the manufacturer's operation and maintenance manuals for new rotary cam limit switches, traffic and barrier gates, packaged engine generators, transfer switches, VFDs, and PLC monitoring equipment.

Submit 7 copies of the shop drawings. Allow 25 days for review. Upon authorization, the Engineer returns 2 copies to you for use during construction.

87-24.01C(3) Certificate of Compliance

Submit a certificate of compliance signed by the supplier's QC representative for the pedestrian warning gate for each shipment.

87-24.02 MATERIALS

87-24.02A General

Provide pedestrian gates as completed assemblies including the components listed below.

1. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; dimensions as shown on the plans. Provide two gasketed access doors for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from the inside of the cabinet. Cabinets must be waterproof.
 - a. Sheet metal used to fabricate the cabinets must meet UL 325 requirements.
 - b. Finish: Baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
 - c. Internal arrangement of equipment in the cabinet shall be such that all equipment is accessible via the access doors.
2. Gate Panel: 2" square aluminum outer frame filled with smaller round aluminum vertical bars, and a perforated sheet metal facing on both sides of the gate panel. The perforations are to be 1/4" diameter and spaced at 5/16" on center. Provide a baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
3. Mounting Bracket: Hot-dipped galvanized steel mounting bracket. Provide a baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
4. Capstan: Capstan must turn in re-lubricable ball roller bearings. Provide a baked-enamel or powder-coat finish. Finish must match color no. #27875 (Insignia White) of AMS-STD-595.
5. Operator: Instant-reversing, continuous-duty motor for operating gate arm.
 - a. Motor Size: Sized according to arm length
 - b. Voltage: 460VAC
 - c. Phase(s): three
 - d. Hertz; 60
 - e. Operating Time: Eight Seconds
 - f. Handcrank for manual operation
 - g. Electrical disconnect
6. Limit Switch: The gate limit switch assembly must be a self-contained unit. The assembly must provide at least 4 independent Single-Pole Double-Throw (SPDT) control switches. The switches must be rated for 15 amps at 480 VAC. Switches must be controlled by individually adjustable cams. The limit switch assembly design shall permit adjustment of all cams with the gate in any position. The limit switch assembly must have a removeable cover to help prevent accidental contact with switch terminals. Shafts, cams, bushings, and house pieces must be non-ferrous corrosion resistant materials.
7. Anchor bolts and hardware to be furnished by the manufacturer.

The pedestrian warning gate and housing are subject to AESS category 3 for visible surfaces.

87-24.03 Construction

Balance all gate arms to ensure arms operate smoothly and reach proper open and closed positions.

87-24.04 Payment

Not Used

Add section 87-25:
87-25 TRAFFIC BOLLARD SYSTEM

87-25.01 GENERAL**87-25.01A Summary**

Section 87-24 includes specifications for furnishing and installing crash rated traffic barrier bollards and corresponding concrete supports.

Traffic Bollard System includes furnishing the units to the job site ready to incorporate into the work and installing the traffic bollard system and concrete supports into the final position in the work.

Concrete must comply with section 51.

Reinforcement must comply with section 52.

87-25.01B Definitions

Traffic Barrier Bollard: a crash rated vehicle security barrier, also known as a pop-up bollard or telescopic bollard, that can be automatically raised and lowered into the ground or roadway.

Concrete Support: a structural element used by the bollard system to resist vehicle impact. Also referred to as the bollard foundation or the concrete bollard housing block.

87-25.01C Submittals**87-25.01C(1) General**

Provide product data for each type of barrier, component, finish, and accessory specified.

Submit manufacturer's field touch-up, cleaning, and maintenance instructions. Maintenance instructions shall include routine maintenance procedures, including bollard replacement, possible breakdowns, and repairs, and troubleshooting guide. The instructions shall include piping layout, equipment layout and simplified wiring, and control diagrams of the systems as installed.

Submit sample of manufacturer's warranty.

Submit an operator manual that contains recommended maintenance intervals, procedures, and replacement parts lists.

Submit calculations, as required, demonstrating the bollards and corresponding concrete supports are in compliance with ASTM F2656. Calculations must be stamped and signed by a California licensed Professional Engineer.

87-25.01C(2) Traffic Bollard System Work Plan

Submit a work plan for the Traffic Bollard System and associated components. The work plan must include:

1. Plan, elevation, and section views illustrating the locations of the bollards, hydraulic power units, bollard foundations, and all other required equipment and materials in relation to the bridge to ensure that all components fit within the space provided.
2. Critical dimensions of all elements
3. Bollard drainage system details
4. Concrete mix design and reinforcement for the bollard foundations
5. Details, as needed, where the bollard and concrete supports will interface with the bridge deck, girder stems, and bridge soffit.
6. Procedures, details, and sequences for installing the bollards and associated components in their final position.

Allow 10 days for review.

87-25.01D Quality Assurance**87-25.01D(1) General**

Manufacturer Qualifications:

1. Company specializing in manufacturing products specified in this section with a minimum of 5-years of documented experience.

Installer Qualifications:

1. Engage an experienced installer who has a minimum of 5-years documented experience with projects of similar scope and complexity.
2. Installer is an authorized representative of the vehicle barrier manufacturer for both installation and maintenance of the type of units furnished for this project.

Provide each type of product from a single manufacturer source to ensure uniformity.

Each Traffic Barrier Bollard must be cycled in-house prior to shipment to ensure proper working order and calibration of switches.

The contractor must provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

The installer must provide training on usage, testing, and maintenance of the system at the completion of construction.

87-25.01D(2) Quality Control

87-25.01D(2)(a) General

Not Used

87-25.01D(2)(b) Testing

Traffic Barrier Bollards must be crash tested to ASTM F2656 or calculations must be provided demonstrating compliance with the crash rating noted in 87-23.02. Calculations must be stamped and signed by an engineer who is registered in the State of California.

Traffic Barrier Bollards must be tested for functionality prior to shipment.

The bollard control system must be tested on site after installation.

87-25.02 MATERIALS

Traffic Barrier Bollards must meet the following requirements:

1. ASTM F2656 Crash Rating C730/7200 (Class 7 Cabover 15,873 lbs. at 35 MPH (7,200 kg at 5p KPH)
2. Penetration Rating: P1
3. Traffic Barrier Bollard: 230 VAC
4. 35" (900mm) in height with minimum cylinder thickness of 0.4" (10 mm)
5. AISI316 brushed stainless steel finish
6. The Traffic Barrier Bollard system must include operable bollard controls with cabling and obstruction detection devices.
7. Raising and lowering time must be a maximum of 4.5 seconds.
8. Cylinders with built-in LED lights, the control unit must manage up to 3 traffic barrier bollards at the same time.
9. Independent hydraulic pump for each Traffic Barrier Bollard.
10. Buzzer and pressure switch for obstacle detection
11. Control panel for traffic Barrier Bollards:
 - a. 230 Vac 50/60 Hz power supply.
 - b. Integrated 433.92 MHz 64-code receiver with 3 encoding systems (Advanced Rolling Code, Rolling Code, Fixed Code)
 - c. Removeable terminal boards
 - d. Parameter and operation logic regulations through integrated LCD display
 - e. Automatic, semi-automatic, and deadman's logic.
 - f. Programming access password
 - g. Equipped with step-by-step command inputs separate for each Traffic Barrier Bollard and centralized command inputs ALL UP and ALL DOWN for raising and lowering Traffic Barrier Bollards.
 - h. Built-in board to manage buzzer/LED lights.

- ## 87-25.03 CONSTRUCTION

87-25.03A(1) Site Examination

The installer must verify that the location of product installation is free and clear of any obstructions or conflicts prior to installation.

The installer must examine and verify the suitability of all products in relation to the installation location.

Prepare the installation surfaces based on manufacturer's recommendations.

The Traffic Barrier Bollards shall be installed per the traffic bollard system work plan.

Construct concrete supports based on the dimensional and weight limits shown on the plans. Notify the engineer immediately if any revisions to the dimensional and/or weight limits shown on the plans are required.

Install the Traffic Barrier Bollards plumb.

Provide a drainage system to drain the Traffic Barrier Bollards.

96 GEOSYNTHETICS

Add to section 96-1.02B:

Filter fabric for Br No. 22C0193 and retaining wall No. 1 through 4 must be Class A.

DIVISION XII BUILDING CONSTRUCTION

99 BUILDING CONSTRUCTION

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Draft
(Not for Bidding)

SECTION 011000 SUMMARY

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: I Street Bridge Operators House
- B. Owner's Name: City of Sacramento.
- C. The Project consists of the construction of of a new I Street Bridge with an adjacent Operators House. This summary is provided for the Oerators House ONLY..

1.02 CONTRACT DESCRIPTION

- A. Refer to the I Street Bridge project solicitation for the contracting provisions.

1.03 OWNER OCCUPANCY

- A. Owner intends to occupy the Project upon Substantial Completion.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.04 SPECIFICATION SECTIONS APPLICABLE TO OPERATORS HOUSE ONLY

- A. Unless otherwise noted, provisions of the sections listed in the Operator House Table of Contents apply ONLY to the construction of the Operators House.

PART 2 PRODUCTS - NOT USED PART

3 EXECUTION - NOT USED

END OF SECTION 011000

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SECTION 013000 ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Web-based project software service.
- B. Electronic document submittal service.
- C. Submittals for review, information, and project closeout.
- D. Number of copies of submittals.
- E. Submittal procedures.

PART 2 PRODUCTS - NOT USED PART

3 EXECUTION

3.01 WEB-BASED PROJECT SOFTWARE SERVICE

- A. Web-Based Project Software Service: Provide, administer, and use web-based project software to host and manage project communication and documentation.
 - 1. Include, at minimum, the following features:
 - a. Project directory, including Owner, Contractor, subcontractors, Architect, Architect's consultants, and other entities involved in the project. Include names of contact persons and contact information for each entity.
 - b. Access control for each entity and for each workflow process to determine each entity's digital rights to create, modify, view, and print documents.
 - c. Workflow planning, allowing customization of workflow for each project entity.
 - d. Creation, logging, tracking, and notification for project communications.
 - e. Tracking of project communication statuses in real time, including timestamped response log.
 - f. Procedures for viewing PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creation and distribution of meeting minutes.
 - j. Document management for drawings, specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility.
 - m. Creation of data analytics reports.

- n. Creation and export of editable logs for software functions. Provide Owner, Architect, and Architect's consultants with rights and ability to download logs when requested.
2. Provide up to 20 user licenses for use by Owner, Architect, Architect's consultants, and other entities involved in the project.
3. Comply with the software service's current published licensing agreements.
4. Training: Provide one-hour, web-based training session for users of software service. Further training is the responsibility of the user.
 - a. Representatives of Owner are scheduled and included in this training.
5. Project Closeout: Architect determines when to terminate the software service for the project and is responsible for obtaining archive copies of files for Owner.
6. Web-Based Project Software Services: The selected service is:

3.02 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 2. Contractor and Architect are required to use this service.
 3. It is Contractor's responsibility to submit documents in allowable format.
 4. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.
 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.
 7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
- B. Submittal Service: The selected service is:
- C. Training: One, one-hour, web-based training session will be arranged for all participants, with representatives of Architect and Contractor participating; further training is the responsibility of the user of the service.
- D. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.03 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.

1. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.

3.04 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.05 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
 1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Bonds.
 5. Other types as indicated.
- D. Submit for Owner's benefit during and after project completion.

3.06 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 1. After review, produce duplicates.
 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.07 SUBMITTAL PROCEDURES

- A. General Requirements:
 1. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.

2. Apply Contractor's stamp, signed or initialed certifying that review, approval, 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.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
 3. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 4. Schedule submittals to expedite the Project, and coordinate submission of related items.
 5. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 6. Provide space for Contractor and Architect review stamps.
 7. When revised for resubmission, identify all changes made since previous submission.
 8. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
 9. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
 10. Submittals not requested will not be recognized or processed.
- B. Product Data Procedures:
1. Submit only information required by individual specification sections.
 2. Collect required information into a single submittal.
 3. Do not submit (Material) Safety Data Sheets for materials or products.
- C. Shop Drawing Procedures:
1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
 2. Do not reproduce Contract Documents to create shop drawings.
 3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.
- D. Samples Procedures:
1. Transmit related items together as single package.
 2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.08 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Architect's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:

- a. "Approved", or language with same legal meaning.
- b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
- c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
- 2. Not Authorizing fabrication, delivery, and installation:
- E. Architect's and consultants' actions on items submitted for information:
 - 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 - 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

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SECTION 014533**CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Code-required special inspections.
- B. Submittals.
- C. Fabricators' field services.

1.02 DEFINITIONS

- A. Code or Building Code: ,California Building Code, most recent edition adopted by authority having jurisdiction, including all applicable amendments and supplements without limitation, and specifically Chapter 17 - Special Inspections and Tests.
- B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
- C. NIST: National Institute of Standards and Technology.
- D. Special Inspections and Tests: Inspections and testing of materials, installation, fabrication, erection, or placement of components and connections mandated by Building Code to safeguard public welfare.
 - 1. Special inspections and tests are separate from and independent of tests and inspections conducted by Owner or Contractor for purposes of quality assurance and contract administration.

1.03 REFERENCE STANDARDS

- A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025a.
- B. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.
- C. IAS AC291 - Accreditation Criteria for Special Inspection Agencies AC291; 2025.
- D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Fabricator's Inspection Reports: When required by AHJ, submit reports to Architect and AHJ.

1.05 SPECIAL INSPECTION AND TESTING AGENCY

- A. Owner Architect to employ services of Special Inspection Agency to perform inspections and associated testing and sampling in accordance with ASTM E329 and required by building code.
- B. Special Inspection Agency may delegate to independent testing agency to perform testing and sampling associated with special inspections and required by building code.
- C. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of contract documents.

1.06 QUALITY ASSURANCE

- A. Special Inspection Agency Qualifications:
 - 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 2. Accredited by IAS according to IAS AC291.
- B. Testing Agency Qualifications:
 - 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 2. Accredited by IAS according to IAS AC89.

PART 2 PRODUCTS - NOT USED PART**3 EXECUTION****3.01 SPECIAL INSPECTIONS AND TESTING**

- A. The Code requires special inspections and testing of certain materials, components, assemblies, and connections used in constructing the project. Special inspections and testing will be performed in accordance with the Code.

3.02 CONTRACTOR DUTIES AND RESPONSIBILITIES

- A. Contractor Responsibilities, General:
 - 1. Deliver to agency at designated location, adequate samples of materials for special inspections that require material verification.
 - 2. Cooperate with agency and laboratory personnel; provide access to approved documents at project site, to the work, to manufacturers' facilities, and to fabricators' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to work to be tested or inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested or inspected.
 - c. To facilitate tests or inspections.
 - d. To provide storage and curing of test samples.
 - 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing or inspection services.

5. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

3.03 FABRICATORS' FIELD SERVICES

- A. When required by AHJ or specified in individual specification sections, require fabricators to provide qualified staff personnel to observe site conditions, installation conditions, quality of workmanship, and start-up of equipment and systems and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

END OF SECTION 014533

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SECTION 030100 MAINTENANCE OF CONCRETE**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Cleaning of existing concrete surfaces.
- B. Repair of exposed structural, shrinkage, and settlement cracks.
- C. Resurfacing of concrete surfaces having spalled areas and other damage.
- D. Repair of deteriorated concrete.
- E. Repair of internal concrete reinforcement.

1.2 RELATED SECTIONS

- A. Section 03 30 30 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.
- B. Section 03 92 50 - Concrete Repair Mortars: Strengthening of interior concrete structural slabs and foundations.

1.3 REFERENCE STANDARDS

- A. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
- B. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement 2016.
- C. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement 2016.
- D. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- E. ASTM C150/C150M - Standard Specification for Portland Cement 2020.
- F. ASTM C404 - Standard Specification for Aggregates for Masonry Grout 2018.
- G. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete 2015.
- H. ASTM C928/C928M - Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs 2020.
- I. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel 2018.
- J. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair 2013.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

- C. Installer's Qualification Statement.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design reinforcement splices under direct supervision of a Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- C. Cleaner Qualifications: Company specializing in, and with minimum of 3 years of experience in, the type of cleaning specified.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum of 3 years of documented experience.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Degreaser:
1. Manufacturers:
 - a. Euclid Chemical Company; Euco Clean and Strip: www.euclidchemical.com/#sle.
 - b. L&M Construction Chemicals, Inc. a subsidiary of Laticrete International, Inc; CITREX: www.lmcc.com/#sle.
 - c. SpecChem, LLC; Orange Peel-Citrus Cleaner: www.specchemllc.com/#sle.
 - B. Detergent: Non-ionic detergent.

2.2 CEMENTITIOUS PATCHING AND REPAIR MATERIALS

- A. See section 03 92 50- Concrete Repair Mortars.
- B. Cementitious Hydraulic Waterstop: Very fast setting, low slump, hand formable, and capable of stopping active water leaks; in-place material resistant to freeze/thaw conditions.
1. Manufacturers:
 - a. Euclid Chemical Company; SPEED PLUG: www.euclidchemical.com/#sle.
 - b. Kaufman Products Inc; SurePlug - regular set: www.kaufmanproducts.net/#sle.
 - c. W. R. Meadows, Inc; Meadow-Plug or Meadow-Patch 5: www.wrmeadows.com/#sle.

2.3 EPOXY PATCHING AND REPAIR MATERIALS

- A. Epoxy Repair Mortar: Epoxy resin mixed with aggregate and other materials in accordance with manufacturer's instructions for purpose intended; comply with pot life and workability limits.
1. Manufacturers:
 - a. ARDEX Engineered Cements; ARDEX BACA: www.ardexamericas.com/#sle.
 - b. Euclid Chemical Company; DURALFLEX FASTPATCH: www.euclidchemical.com/#sle.
 - c. Kaufman Products Inc; SurePox Mortar, SurePox HMLV, or SurePox HMLV Class B: www.kaufmanproducts.net/#sle.
 - B. Epoxy Injection Adhesive:

1. Manufacturers:
 - a. Euclid Chemical Company; DURAL FAST SET LV: www.euclidchemical.com/#sle.
 - b. Kaufman Products Inc; SurePoxy HM, SurePoxy HMLV, SurePoxyHMLV Class B, or SurePoxy HMSLV: www.kaufmanproducts.net/#sle.
 - c. W. R. Meadows, Inc; Rezi-Weld LV, Rezi-Weld LV State, Rezi-Weld (IP), or Rezi- Weld Gel Paste: www.wrmeadows.com/#sle.
- C. Epoxy Bonding Adhesive: Non-sag, two-component, 100 percent solids; recommended by manufacturer for purpose and conditions under which used.
 1. Non-Load-Bearing Applications: ASTM C881/C881M Type I, II, III, IV, or V, whichever is appropriate to application.
 2. Manufacturers:
 - a. ARDEX Engineered Cements; ARDEX BACA: www.ardexamericas.com/#sle.
 - b. Euclid Chemical Company; DURAL FAST SET LV: www.euclidchemical.com/#sle.
 - c. W. R. Meadows, Inc; Rezi-Weld Gel Paste: www.wrmeadows.com/#sle.

2.4 ACCESSORIES

- A. Anchoring Adhesive: Self-leveling or non-sag as applicable.
 1. Self-Leveling Polyester-Based Products:
 - a. W. R. Meadows, Inc; Poly-Grip: www.wrmeadows.com/#sle.
- B. Portland Cement: ASTM C150/C150M, Type I, grey.
- C. Sand: ASTM C33/C33M or ASTM C404; uniformly graded, clean.
- D. Water: Clean and potable.
- E. Reinforcing Steel: ASTM A615/A615M Grade 40 (40,000 psi) billet-steel deformed bars, unfinished.
- F. Reinforcing Steel: Deformed bars, ASTM A996/A996M Grade 40 (280), Type A.
 1. Galvanized in accordance with ASTM A767/A767M, Class I.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

3.2 PREPARATION

- A. Prepare concrete surfaces to be repaired according to ICRI310.2R.

3.3 CLEANING EXISTING CONCRETE

- A. Clean concrete surfaces of dirt or other contamination using the gentlest method that is effective.
 1. Try the gentlest method first, then, if not clean enough, use a less gentle method taking care to watch for impending damage.
 2. Clean out cracks and voids using same methods.
- B. The following are acceptable cleaning methods, in order from gentlest to less gentle:
 1. Water washing using low-pressure, maximum of 100 psi, and, if necessary,

brushes with natural or synthetic bristles.

2. Increasing the water washing pressure to maximum of 400 psi.
3. Adding detergent to washing water; with final water rinse to remove residual detergent.
4. Steam-generated low-pressure hot-water washing.

3.4 CONCRETE STRUCTURAL MEMBER REPAIR

- A. See drawings for specific areas to be repaired.
- B. Remove broken and soft concrete at least 1/4 inch deep.
- C. Mechanically cut away damaged portions of reinforcement.
- D. Remove corrosion from steel and clean mechanically.
- E. Blast clean remaining exposed reinforcement surfaces.
- F. Repair by welding new bar reinforcement to existing reinforcement using sleeve splices.
 1. Perform welding work in accordance with AWS D1.4/D1.4M.
 2. Make welded sleeve splices to achieve strength to exceed strength of new reinforcement.
- G. Follow repair product manufacturer's written installation instructions.
- H. Cover exposed steel reinforcement with epoxy mortar.

3.5 CRACK REPAIR USING EPOXY ADHESIVE INJECTION

- A. Repair exposed cracks.
- B. Provide temporary entry ports spaced to accomplish movement of fluids between ports; no deeper than the depth of the crack to be filled or port size diameter no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
- C. Inject adhesive into ports under pressure using equipment appropriate for particular application.
- D. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.
- E. Remove temporary seal and excess adhesive.
- F. Clean surfaces adjacent to repair and blend finish.

3.6 CONCRETE SURFACE REPAIR USING CEMENTITIOUS MATERIALS

- A. Clean concrete surfaces, cracks, and joints of dirt, laitance, corrosion, and other contamination using method(s) specified above and allow to dry.
- B. Apply coating of bonding agent to entire concrete surface to be repaired.
- C. Fill voids with cementitious mortar flush with surface.
- D. Apply repair mortar by steel trowel to a minimum thickness of 1/4 inch over entire surface, terminating at a vertical change in plane on all sides.
- E. Trowel finish to match adjacent concrete surfaces.

3.7 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 01 40 00, will perform field inspection and testing.

END OF SECTION 03 01 00

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Section 031100
CONCRETE FORMING**PART 1 - GENERAL****1.1 SCOPE**

This section specifies the work necessary to furnish, place, and remove all formwork for cast-in-place concrete.

1.2 QUALITY ASSURANCE**A. References**

The publications referred to hereinafter form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.

1. American Concrete Institute (ACI) Publications:

ACI-347 *Recommended Practice for Concrete Formwork*

2. International Conference of Building Officials (ICBO) Publications:

CBC *California Building Code 2022 Edition*

3. U.S. Product Standard (PS) Publications:

PS-1 *Product Standard for Construction and Industrial Plywood*

The Contractor shall comply fully with the requirements of Section 1717 of the Construction Safety Orders, State of California, Department of Industrial Relations, regarding the design of concrete forms, falsework and shoring, and the inspection of same prior to placement of concrete. Where the said Section 1717 requires the services of a civil engineer registered in the State of California to approve design calculations and working drawings of the falsework or shoring system, or to inspect such system prior to placement of concrete, the Contractor shall employ a registered civil engineer for these purposes, and all costs therefore shall be included in the price named in the Contract for completion of the work as set forth in the Contract Documents.

Except as modified by the requirements specified herein and/or the details on the drawings, concrete formwork shall conform to the California Building Code (CBC), Chapter 19, "Concrete", 2022 Edition, the American Concrete Institute – 347 (ACI-347) Guide to Formwork for Concrete, APA Concrete Forming Design/Construction Guide.

1.3 SUBMITTALS**A. The Contractor shall submit information to substantiate compliance with this specification. In addition, the following specific information shall be submitted.****1. Mill Affidavits**

The Contractor shall submit mill affidavits stating the grade and physical properties of form materials before the materials are delivered to the site. The affidavits shall

demonstrate that the materials and procedures comply with the specifications of this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms for Exposed Finish Concrete

Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on the contract drawings. Provide form material with sufficient thickness to withstand pressure of newly- placed concrete without bow or deflection.

Use plywood complying with PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete

Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material as determined by the Construction Manager. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Form Ties

Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent deflection, and to prevent spalling concrete surfaces upon removal. Ties shall be provided with a tightly fitting washer at midpoint.

Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1 ½-inch from the outer concrete surface. Unless otherwise indicated, provide form ties which will leave a cone-shaped depression at the surface at least 1-inch diameter and 1 ½-inch deep to allow filling and patching.

D. Form Coatings

Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMS

A. General

Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position.

Design formwork to be readily removable without impact, shock, or damage to cast-in- place concrete surfaces and adjacent materials.

Construct forms in compliance with ACI 347, to sizes, shapes, lines and dimensions

shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

Chamfer all exposed corners and edges with $\frac{3}{4}$ -inch chamfers unless otherwise noted on the contract drawings, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints. Fillets are not required unless otherwise noted on the contract drawings.

B. Exposed Surface Form Tolerances

Forms for exposed concrete surfaces shall be designed and constructed so that the formed surface of the concrete does not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Undulations exceeding either $\frac{3}{32}$ -inch or $\frac{1}{270}$ of the center to center distance between studs, joists, form stiffeners, form fasteners or wales will be considered to be excessive. Should any form or forming system, even though previously approved for use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications satisfactory to the Construction Manager have been made. Portions of concrete structures with surface undulations in excess of the limits herein may be rejected by the Construction Manager.

C. Form Ties

Install factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed and spaced to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

D. Provisions for Other Trades

Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

E. Cleaning and Tightening

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

3.2 PREPARATION OF FORM SURFACES

- A. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
- B. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until the concrete has attained the 28-day design compressive strength. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.4 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.

END OF SECTION 03 11 00

**SECTION 032000 CONCRETE
REINFORCING****PART 1 - GENERAL****1.1 SCOPE**

This section covers the furnishing and installing of reinforcing steel for cast-in-place concrete work as shown and noted on the plans and as specified.

1.2 QUALITY ASSURANCE

The publications referred to hereinafter form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.

A. References

The editions of the specifications and standards referenced herein, published by the following organizations, apply to the work only to the extent specified by the reference. The latest version in effect at the time of bid shall apply.

1. American Concrete Institute (ACI)
2. American Society for Testing and Materials (ASTM)
3. Concrete Reinforcing Steel Institute (CRSI)
4. American Welding Society (AWS)

B. Regulatory Requirements

Except as modified by the requirements specified herein and/or the details on the plans, concrete reinforcing work shall conform to the 2022 Edition of California Building Code (CBC), Chapter 19, "Concrete" and the requirements of the CRSE Manual of Standard Practice.

1.3 SUBMITTALS

The Contractor shall submit information to substantiate compliance with this specification. In addition, the following specific information shall be submitted.

A. Shop Drawings

Submit shop and placement drawings of all reinforcing for review.

Placement drawings shall show the locations and spacing of reinforcing in the various parts of the structure with details as required, all in accordance with ACI 315. Cutting and bending lists submitted without placement drawings will be returned without review as incomplete. Placement drawings shall not be reproduced, marked up copies of the design drawings. Placement drawings shall be complete so that placement of the reinforcing may proceed without reference to the plans.

Review shall not act to relieve the Contractor from responsibility for accuracy of the fabrication details and placing diagrams. Dimensions and locations shall be verified prior to the preparation of shop drawings.

No work shall be done except from reviewed drawings which must be kept at all work locations.

B. Mill Affidavits

Mill affidavits, stating the grades and physical and chemical properties of the reinforcing steel, and conformance with ASTM specifications, shall be submitted before delivery of the steel to the job site.

At the completion of the work, one complete set of placement bending diagrams shall be delivered to the Construction Manager for record purposes.

1.4 DELIVERY AND STORAGE

Deliver reinforcement bundled and tagged to identify placement and certify testing.

Reinforcing steel shall be transported to the building site, stored and covered in a manner which will insure that no damage shall occur to it from moisture, dirt, grease, or any other cause that might impair bond to concrete. A sufficient supply of approved reinforcing steel shall be stored on the site at all times to insure that there will be no delay of the work. Identification of steel shall be maintained after bundles are broken.

1.5 COORDINATION

Contractor shall check structural, civil, mechanical, and electrical drawings for anchor bolt schedules and locations, anchors, inserts, conduits, sleeves, and any other items which are required to be cast in concrete, and shall make necessary provisions as required so that reinforcing steel will not interfere with the placement of such embedded items.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars

New, deformed, billet steel bars, conforming to ASTM A615. Deliver bars new and free from rust and mill scale in original bundles with mill tags intact. Grade 60 for all bars.

Reinforcing bars to be welded shall be weldable steel ASTM A706, Grade 60 for all bars.

B. Epoxy

Epoxy shall be used to drill and bond reinforcement dowels into existing concrete. Epoxy shall be Hilti RE, Simpson "SET-3G", or an approved equal. The approved equal shall be equal in materials, strength, and intended use.

C. Accessories

Reinforcement accessories, consisting of spacers, ties, and similar items shall be provided as required for spacing, assembling, and supporting reinforcement in place. Accessories shall be reinforcing steel or precast concrete blocks conforming to the applicable requirements of the *CRSI Manual of Standard Practice*.

D. Tie Wire

Tie wire for reinforcement shall be No. 16 gage or heavier, where noted or specified, black or galvanized steel wire, conforming to ASTM A82.

E. Welding Electrodes

AWS A5.1, grade E70XX for welding grade 40 reinforcing steel and E90XX for welding grade 60.

F. Bar Lock Reinforcing Couplers

Reinforcing couplers shall be Dayton L Series Bar Lock couplers or an approved equal. The approved equal shall be equal in materials, strength, and intended use.

PART 3 - EXECUTION

3.1 FABRICATION

Fabrication of steel reinforcement shall be in accordance with the details shown on the plans. Where specific details are not shown or noted, comply with the applicable requirements of ACI 315.

Bars shall be accurately bent, cut and placed as indicated on the plans. Bars shall be bent cold; heating of bars will not be permitted. Bars shall not be bent or straightened in any manner that will injure the material. All reinforcing bars shall be bent in an approved fabricating shop. Field bending of reinforcement shall not be permitted.

3.2 PLACING

A. General

Reinforcing steel shall be placed in accordance with the plans and the applicable requirements of the latest edition of the *CRSI Manual of Standard Practice* and the California Building Code, Chapter 19, "Concrete." Install reinforcement accurately and secure against movement, particularly under the weight of workmen and the placement of concrete.

B. Reinforcing Supports

Bars and welded wire fabric layers shall be supported on precast concrete blocks wire tied to reinforcement and accurately placed. Spacing of blocks and accessories shall conform with *CRSI's Recommended Practice for Placing Bar Supports*. No wood will be permitted inside forms. Precast concrete blocks shall be used to support footing and slab reinforcing on ground and slab and beam reinforcement on horizontal form work.

C. Placing and Tying

All reinforcing shall be set in place, spaced, and rigidly and securely tied or wired with No. 16 gage steel tie wire at all splices and at crossing points and intersections in the position shown, or as directed by the Construction Manager. Point ends of wire away from forms.

D. Spacing

Bars shall be spaced as indicated on the plans. Where not shown, the clear spacing for main longitudinal reinforcement shall be not less than 1.5 times the nominal bar diameter, or 1 1/2-inch, or 1 1/3 times the maximum size aggregate, whichever is greater. For all other parallel bars, where spacing is not shown, the minimum clear spacing shall not be less than the nominal bar diameter, or 1-inch, or 1 1/3 times the maximum size aggregate, whichever is less. The clear distance limitations above also apply between the bars being spliced at a contact lap splice and adjacent bars.

E. Splices

Except for temperature bars in slabs and horizontal wall reinforcing, no splicing will be allowed for reinforcing bars unless detailed locations are given for these splices on the plans, or approval is given. Stagger lapped splices for horizontal wall reinforcing and slab temperature bars by the required lap splice length minimum. Wherever possible, splices of adjacent bars shall be staggered.

Reinforcing bars may be continuous at locations where splices are shown on the plans, at the option of the Contractor. The location of splices, except where shown on the plans, shall be determined by the Contractor based upon using available commercial lengths where practicable.

F. Dowels

Dowels to be placed in new concrete or masonry shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowels may be tied, No. 3 bars shall be added to provide proper support and anchorage. Dowels to be installed in existing concrete shall be drilled and bonded into place using epoxy.

Horizontal holes shall be drilled at a slight downward angle to facilitate holding the epoxy. Reinforcing steel installed in horizontal holes shall be bent slightly accordingly. Bending of dowels after placement of concrete will not be permitted unless approval is obtained. Dowels extended for future construction shall be protected from weather as shown on the plans. Compliance with safety law requirements for extended dowels is required.

G. Cleaning

Reinforcement, at time of pour, shall be free of mortar, oil, dirt, excessive mill scale, scabby rust and other coatings that would impair bond to concrete.

H. Welding

Welding of reinforcing steel shall comply with AWS D1.4. Do not weld reinforcing steel until a chemical analysis sufficient to determine the carbon equivalent of the steel has been performed. This analysis shall be made from the chemical composition shown in the mill test reports or by chemical analysis of bars representative of the bars to be welded. The carbon equivalent shall not exceed 0.55. Preheating of Grade 60 bars will be required immediately prior to welding.

3.3 TESTING AND INSPECTION

Contractor shall provide notification at least 2 working days ahead of each concrete pour, and no concrete shall be placed until all reinforcing steel has been installed by the Contractor and approved by the Construction Manager. All reinforcing shall be complete in every way by the end of the working day prior to concrete placing.

3.4 SPECIAL INSPECTION

Special inspection is required as defined in CBC Chapter 17.

3.5 DEFECTIVE WORK

The following reinforcing steel work will be considered defective and shall be removed and replaced by the Contractor at no additional cost to the City.

- A. Bars with kinks or bends not shown on plans.
- B. Bars injured due to bending or straightening.
- C. Bars heated for bending.
- D. Reinforcement not placed in accordance with the plans or specifications.

END OF SECTION 03 20 00

SECTION 033030 CAST IN PLACE CONCRETE**PART 1 - GENERAL****1.1 SCOPE**

This section covers the furnishing and placing of cast-in-place concrete as indicated and as specified.

1.2 QUALITY ASSURANCE

The publications referred to hereinafter form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.

A. References

The editions of the specifications and standards referenced herein, published by the following organizations, apply to the work only to the extent specified by the reference. The latest version in effect at the time of bid shall apply.

1. American Concrete Institute (ACI)
2. American Society for Testing and Materials (ASTM)
3. Corps of Engineers Specifications (CRD)
4. California Building Code (CBC)

B. Regulatory Requirements

Except as modified by the requirements specified herein and/or the details on the plans, concrete work shall conform to the California Building Code (CBC), Chapter 19, "Concrete", 2022 Edition.

1.3 SUBMITTALS

The Contractor shall submit information to substantiate compliance with this specification. In addition, the following specific information shall be submitted.

- A. Certificates of compliance for Portland cement.
- B. Manufacturers technical literature that certify compliance with applicable standards as indicated in these specifications for admixtures, curing compounds, expansion joint filler, sealer and chemical hardener, and all other concrete products to be used.
- C. Concrete mix design.
- D. Proposed construction joint locations and pour sequences.
- E. Preliminary installation plan including concrete pours.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Portland Cement

Portland cement shall be either "Type IP (MS) Modified" or "Type II Modified". "Type IP (MS) Modified" cement shall conform to the specifications for Type IP (MS) cement in ASTM C595 and shall be comprised of an intimate mixture of "Type II Modified" cement and not more than 15% of a pozzolanic material. "Type II Modified" cement shall conform to the specifications of Type II cement in ASTM C150. In addition, for "Type IP (MS) Modified" and "Type II Modified" cement shall conform to the following requirements:

1. The cement shall not contain more than 0.60% by weight of alkalis, calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O when determined by either direct intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in accordance with the requirements of ASTM C114.
2. The autoclave expansion shall not exceed 0.50%.
3. Mortar, containing the portland cement to be used and Ottawa sand, shall not expand in water more than 0.010% and shall not contract in air more than 0.048%.

Mineral admixtures may be used to replace a portion of the required portland cement in accordance with the provisions of Paragraph 2.01B, Mineral Admixture.

All cement used in the manufacture of cast-in-place concrete for exposed surfaces of like elements of a structure shall be from the same cement mill.

Cement shall be protected from exposure to moisture until used. Sacked cement shall be piled to permit access for tally, inspection, and identification of each shipment.

B. Mineral Admixture

1. Mineral admixture shall conform to ASTM C618, Type F or C.
2. Required use: For all liquid bearing concrete structures, the concrete shall conform with either:
 - a. Concrete containing "Type IP (MS) Modified" cement conforming to the provisions in Paragraph 2.01A, Portland Cement, in an amount sufficient to satisfy the specified minimum cement content. The modified cement shall contain a minimum of 15%, by weight, pozzolanic material.
 - b. Concrete containing "Type II Modified" cement conforming to the provisions in Paragraph 2.01A, Portland Cement, in an amount not less than 85% of the amount required to satisfy the specified minimum cement content. The concrete shall also contain a mineral admixture in an amount not less than 15% by weight, of the amount of cement required to satisfy the specified minimum cement content.
3. Optional Use: At structures other than liquid bearing concrete structures, the Contractor will be permitted to replace up to 15% of the required Portland cement, other than "Type IP (MS) Modified", with a mineral admixture. The weight of the mineral admixture used shall be equal to or greater than the weight of Portland cement replaced.
4. Admixtures shall conform to ASTM C494, be of a type that increases workability and reduces water demand of concrete, but will not increase shrinkage. Admixtures shall be subject to approval as to type and amount used. Admixtures shall contain not

more than 1% chloride ions.

C. Concrete Aggregates

Before beginning concrete work, the Contractor shall submit in writing to the Construction Manager the gradation of the primary aggregate nominal sizes which he proposes to furnish. If the primary coarse aggregate or the fine aggregate is separated into two or more sizes, the proposed gradation shall consist of the gradation for each individual size, and the proposed portions of each individual size, combined mathematically to indicate one proposed gradation. Such gradation shall meet the grading requirements shown in ASTM C33 for normal weight concrete and ASTM C330 for lightweight concrete.

In lieu of the use of ASTM C227 to determine alkali reactivity of the aggregates as specified therein, the alkali reactivity shall be "innocuous" as determined by ASTM C289.

Fine aggregate shall be washed clean, shall be uniformly screen graded, and shall contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth, loam, mica or similar materials. Fine aggregate shall be graded uniformly from fine to coarse.

Coarse aggregate shall consist of clean, hard, crushed rock or washed gravel, free from organic materials or soft or friable materials and shall not contain more than 2% by weight of shale or cherty material and not more than 15% by weight of elongated fragments. Work fragments are strictly prohibited.

D. Admixtures

ASTM C494, of a type that increases workability and reduces water demand of concrete, but will not increase shrinkage. Admixture shall be subject to approval as to type and amount used. Admixtures shall contain not more than 1% chloride ions.

E. Air-Entraining Agent

ASTM C260, subject to approval by the Engineer.

F. Water Used in Mixing Concrete

Potable, clean and free from deleterious amounts of acid, alkalis, organic or other materials.

G. Curing Membrane

Nonstaining paper conforming to ASTM C171, or 6 mil thick polyethylene film.

H. Curing Compound

ASTM C309, liquid membrane forming, with fugitive dye for identification. Compound shall be compatible with finish to be applied thereto. Curing compound and areas receiving it must be approved by the Construction Manager.

I. Bonding Compounds

Epoxy resin bonding compounds shall be used for all concrete repairs and shall be Degusa Admixtures, Inc. Concessive Liquid (LPL), Paste (LPL), or Paste (SPL), as applicable; or ChemCo Liquid (LWL), Paste (LWL), Paste (SWL), as applicable or approved equal.

Non-epoxy bonding compounds may be used for dry areas and shall be Intralock as

manufactured by W.R. Meadows, Weld-Crete as manufactured by Larsen Products Corp, or equal.

J. Bonding compounds shall be applied in accordance with the manufacturer's instructions.

2.2 PROPERTIES AND PROPORTIONS

A. Concrete

All concrete shall be normal weight concrete unless otherwise specified herein. Normal weight concrete shall have a minimum density of 150 pounds per cubic foot. Light weight concrete shall have a maximum density of 110 pounds per cubic foot.

The Contractor shall be responsible that the concrete formulation meet all aspects of this specification i.e., 28 day compressive strength, etc. Provide concrete conforming to the following unless otherwise noted on the plans:

Location	28 Day Compressive Strength (psi)	Maximum Aggregate Size (inch)	Slump ($\pm 1"$)	Maximum Water- Cement Ratio (by weight)
Spread Footings	4,000	1	4	0.50
Mat Foundations	4,000	1	4	0.50
Pier Footings	4,000	1	4	0.50
Slab on Grade	4,000	1	4	0.45
Concrete Repairs	3,500	3/4	4	0.45

The quantity of cement to obtain the strength is the sole responsibility of the Contractor. To assure durable concrete using local materials, a minimum weight of cement/yd³ (excluding all other cementitious materials) shall be used for the following:

1. 3,000 psi Concrete = 517 lbs
2. 3,500 psi Concrete = 564 lbs

In no case shall the maximum aggregate size used exceed 20% of a member's thickness, nor 3/4 of the clear distance between reinforcing.

2.3 LABORATORY TESTS AND MIX DESIGNS

A. General

Compression tests of concrete shall be performed by a qualified testing laboratory retained and paid by the City. Mill tests and manufacturer's certification of compliance with ASTM Specifications may be submitted to the City in lieu of testing of cement and aggregate analysis.

B. Mix Designs

Contractor shall employ an approved testing laboratory who shall determine mix designs to fulfill the specified requirements for strength, aggregate size and workability of concrete, and such designs shall be used in proportioning all structural concrete. Mix designs shall be submitted for review by the Construction Manager.

Mix designs shall be made in accordance with ACI 211.1.

Cover and clear distances between reinforcing bars shown on the plans shall be considered in determining the aggregate size for mix designs and may result in an aggregate size smaller than the maximum aggregate size allowed elsewhere in this specification.

A list of where the mix designs are to be used shall accompany the designs.

Review shall not be considered unqualified approval, and shall not relieve the Contractor of his responsibility to furnish concrete of proper consistency and specified strengths.

2.4 MIXING

Ready mixed concrete shall be mixed and transported in accordance with ASTM C94.

Concrete shall be mixed only in quantities for immediate use and shall be placed within 1 1/2 hours after the introduction of water to the mixture. Concrete which has set shall be discarded and shall not be retempered.

Indiscriminate addition of water to increase slump shall be prohibited. If concrete arrives at the project with slump below that suitable for placing, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. Additional water shall be added to the concrete one time only, upon immediate delivery of the concrete to the job site. The water must be incorporated by additional mixing equal to at least half of the total mixing required. Any addition of water above that permitted by the limitation of water-cement ratio must be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio. Such addition must be approved by the Construction Manager.

PART 3 - EXECUTION

3.1 CONVEYING AND PLACING CONCRETE

A. Notification

Notify the Construction Manager at least two working days in advance of placing concrete.

B. Preparation Before Placing

Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.

Formwork shall have been completed; excess water shall have been removed; reinforcement shall have been secured in place; expansion joint materials, anchors, and other embedded items shall have been positioned; and the entire preparation shall have been approved on the day before the placing of concrete.

Semiporous subgrades shall be sprinkled sufficiently to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.

Before placing of any concrete, all forms shall be thoroughly cleaned, washed out with

water, and made tight. Before reinforcing steel is placed on top of and/or adjacent to forms which have been sealed, the surface sealer shall be wiped off so that none may be traced over, or in any other way come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.

All incrustation shall be removed from forms and reinforcing steel at construction joints.

Before depositing new concrete on or against hardened concrete, retighten forms and roughen surface of hardened concrete as follows. Concrete which has been placed longer than 3 1/2 hours, but less than 6 1/2 hours, prepare by removing all laitance from concrete by wire brushing. Concrete which has been placed longer than 6 1/2 hours, prepare by sand blasting to roughen surfaces to a 1/4-inch amplitude and remove curing compounds previously applied to the construction joint. Thoroughly clean off foreign matter and laitance, and moisten with water.

C. Placement

Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent separation or loss of ingredients.

Conveying equipment shall be of size and design to ensure a continuous flow of concrete at the delivery end.

Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams, planes, or weakness within the section, or visible pour lines in the finish surface.

All concrete shall be consolidated by vibration so that the concrete is thoroughly worked around the reinforcement, around the embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. All mechanical vibrators shall have a minimum frequency of 7,000 rpm and shall be operated by competent workers. Over-vibration and use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at many points, from 18 to 30-inch apart, for 5 to 15 seconds duration. A spare vibrator shall be kept on the job site during all concrete placing operations. Particular care shall be given at exposed concrete surfaces.

Concrete for horizontal members and sections shall not be placed until the concrete in the supporting vertical members or sections has been consolidated and settlement due to bleeding has occurred.

Free fall placement of concrete is limited to 6 ft.

3.2 REPAIR OF SURFACE DEFECTS

A. Repair of Surface Defects

All form tie holes shall be filled and repairable defective areas patched and cured immediately after the forms have been removed. Remove fins and burrs.

B. Removal

After forms have been removed, any concrete which is not formed as shown on the plans, or does not meet the approval of the Construction Manager shall be removed and replaced. Defective surfaces may be repaired and patched in accordance with the following procedure. All conditions requiring patches and completed patches will be inspected. Patches disapproved as not restoring the quality and appearance of the

surrounding work shall be removed and replaced so as to match the surrounding work.

C. Repair Procedure

All honeycombed and other defective concrete shall be removed to sound concrete, but in no case to a depth of less than 1-inch. The area to be patched and an area of at least 6-inch wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bond of neat Portland cement, water, and if permitted, some fine sand passing a No. 30 sieve, shall be mixed to the consistency of thick cream and shall then be well brushed into the surface. Other concrete bonding agents may be used when approved.

The patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the gray Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.

The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

After surface water has evaporated from the areas to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for 7 days.

Before proceeding with any patch work, the Contractor is responsible for establishing trial patch areas to develop the approved patching color and the method of applying and surface-texturing the patching material.

3.3 FORMED SURFACE FINISHES

Formed surfaces shall be finished as soon as practicable after form removal and repair of surface defects. Finishes shall be as follows:

A. Finish A

Finish A shall be a grout clean finish in accordance with ACI 301, Section 10.3.2. To identify any surface air pockets and other defects, surfaces shall be lightly sandblasted prior to sacking. For interior areas not exposed to moisture or weather, water used in the mortar shall be mixed with a PVA bonding compound as recommended by the manufacturer. Finish A shall be provided for all painted surfaces and unpainted surfaces as follows: surfaces of stair wells, interior surfaces of equipment rooms, operations areas, structures exposed to view, and permanently exposed (i.e. not covered) vertical and sloped surfaces, such as pipe chases or valve vaults. The interior walls and above grade exterior walls of the retention basin shall have Finish A.

3.4 RELATED SURFACES

A. Finishing of Unformed Surfaces

1. Related Unformed Surfaces: Tops of walls or buttresses, horizontal offsets, and

similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the adjacent formed surfaces. Final treatment of formed surfaces shall continue uniformly across the unformed surfaces.

3.5 PROTECTION AND CURING

A. General

Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures, and shall be maintained without drying at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete.

B. Initial Curing

Initial curing shall immediately follow the finishing operation. Concrete shall be kept continuously moist at least overnight. One of the following materials or methods shall be used.

1. Ponding or continuous sprinkling.
2. Absorptive mat or fabric kept continuously wet.
3. Sand or other covering kept continuously wet.
4. Curing compounds shall be applied in accordance with the recommendations of the manufacturer and shall not be used on any surfaces against which additional concrete or other cementitious finishing materials are to be bonded, or on surfaces to be coated, waterproofed, moistureproofed, tiled, roofed, or on surfaces on which such curing is prohibited by these specifications.

C. Final Curing

Immediately following the initial curing and before the concrete has dried, additional curing shall be accomplished by one of the following materials or methods.

1. Continuing the method used in initial curing.
2. Waterproof paper covering.
3. Other moisture-retaining coverings as approved.

D. Duration of Curing

The final curing shall continue until the cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of the air in contact with the concrete is above 50°F has totaled 7 days. If high early strength of concrete has been used, the final curing shall continue for a total of 3 days. Rapid drying at the end of the curing period shall be prevented.

E. Formed Surfaces

Steel forms heated by the sun and all wood forms in contact with the concrete during the final curing period shall be kept wet. If forms are to be removed during the curing period, one of the above curing materials or methods shall be employed immediately. Such curing shall be continued for the remainder of the curing period.

F. Protection from Mechanical Injury

During the curing period, the concrete shall be protected from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage caused by construction equipment, materials, or methods, and by rain or running water. Self-supporting structures shall not have form supports removed until the concrete strength has met the requirements of Section 03 11 00, CONCRETE FORMING.

3.6 CONSTRUCTION JOINTS

A. General

Concrete in each unit of construction shall be placed continuously. Before new concrete is placed on or against concrete which has set, forms shall be retightened, and the surface of the set concrete shall be cleaned of foreign matter. Concrete surfaces on which new concrete is placed shall not be wetted.

B. Construction

Construction joints shall be formed as specified. A rough surface of exposed concrete aggregates shall be produced using a surface retardant at construction joints, including joints between slab and topping concrete. The limit of the treated surfaces shall be 1- inch away from the joint edges. Within 24 hours after placing, retarded surface mortar shall be removed either by high pressure water jetting or stiff brushing or combination of both so as to expose aggregate. A rough surface of exposed aggregate may also be produced by abrasive blasting followed by high pressure water jetting. Abrasive blasting, if used, shall remove 1/4-inch of laitance film and shall expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

Provide submittal of shop drawings for construction joint layout as specified and necessary for construction purposes.

C. Locations

Construction joint locations shall be as follows:

1. Walls exceeding 60 feet in length shall be cast in panels not to exceed 50 feet in length. Where the number of panels is three or more, the panels shall be cast in an alternating pattern, unless 5 days have elapsed between casting of adjoining panels.
2. Joints in beams or girders shall be located at or near the quarter points between permanent supports.
3. Joints in the members of a floor system, if needed, shall be made at or near the outer quarters of the span.
4. Joints in walls and columns shall be at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs. Joints in columns shall be perpendicular to the axis.
5. Unless otherwise noted on the plans, water treatment structure foundation slabs shall be cast in panels not to exceed 50 feet in length or not to exceed 2,500 ft² in area. Panels shall be cast in checkerboard patterns. Minimum lapsed time between placing adjacent panels shall be 24 hours.

Reinforcing steel and welded wire fabric shall be continued across construction joints unless shown otherwise on the plans. Girders and floor slabs shall not be constructed over columns or walls until at least 1 hour has elapsed to allow for

shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder unless otherwise specified. Joints shall be perpendicular to the main reinforcement. Waterstops shall be provided in construction joints at locations as specified in Paragraph 3.10, Waterstops, of this section.

3.7 INSERTS AND EMBEDMENTS

A. Inserts

Where pipes, castings or conduits are to pass through structures, the Contractor shall place such pipes or castings in the forms before placing the concrete; or the Contractor may provide openings in the concrete for subsequent insertion of such pipes, casting or conduits. Such openings shall be provided with waterstops and V-shaped construction joint and shall have a slight flare to facilitate grouting and permit the escape of entrained air during grouting.

Additional reinforcement shall be provided around large openings as shown. The grout shall be nonshrink grout as specified in Section 03 60 00, GROUTING.

B. Embedments

Gate frames, gate thimbles, special castings, channels or other miscellaneous metal parts that are to be embedded in the concrete shall be set and secured in the forms prior to concrete placement. Unless otherwise specified, anchor bolts and inserts shall be embedded in concrete as shown. The Contractor shall provide inserts, anchors or other bolts necessary for the attachment of piping, valves, metal parts and equipment. Nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish and similar work shall be provided. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. Operators or sleeves for gate or valve stems shall be positioned to clear reinforcing steel, conduit and other embedments, and to align accurately with equipment.

3.8 MODIFICATION OF EXISTING CONCRETE

Existing concrete shall be removed and the remaining surfaces resurfaced as specified. Subgrade materials under removed concrete shall meet the project specification for subgrade. The remaining concrete shall be protected from damage. Where possible, clean lines shall be made by sawing surfaces at least ½-inch deep and chipping through the existing concrete. The concrete may be broken out after initial saw cuts in the event thickness prevents cutting through. Where it is not possible to use a saw, the initial cuts shall be made with chipping hammers. These cuts shall be sufficient to prevent damage to the remaining concrete. In general, an opening in existing concrete shall be oversized 1-inch on all sides and built back to the correct dimension with an epoxy grout. Cut or broken concrete surfaces shall be resurfaced with an epoxy grout. Concrete surfaces to be coated shall be dry. Where new concrete adjoins existing concrete surfaces, or surfaces which have been cut, such surfaces shall be cleaned by abrasive blasting to remove laitance, loose coatings and foreign materials, and coated with the bonding compound just prior to the placement of the new concrete. Bonding compounds shall be as specified in Paragraph 2.01 L, Bonding Compounds, of this section. Unless otherwise specified, continuity of reinforcing steel shall be obtained across the joint either by exposing existing bars to provide sufficient laps with new bars or by welding existing bars with new bars. Welding of reinforcing steel shall conform to Section 03 20 00 Concrete Reinforcing. Where shown, dowels shall be drilled and set into existing concrete with epoxy. Epoxy shall conform to Section 03 20 00 Concrete Reinforcing.

3.9 FIELD SAMPLING AND TESTS

Field sampling and testing will be performed by the City. Samples of aggregates and concrete shall be taken at random locations and at such times as to represent the quality of the materials and work throughout the project. The City will provide the necessary labor, materials and facilities for sampling the aggregate and for casting, handling and storing the concrete samples at the site of work.

3.10 SPECIAL INSPECTION

Special inspection is required as defined in CBC Chapter 17.

3.11 DEFECTIVE WORK

Defective concrete work shall be removed and replaced at Contractor's expense.

END OF SECTION 03 30 30

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**SECTION 033511 CONCRETE
FLOOR FINISHES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Surface treatments for concrete floors and slabs.
- B. Clear coatings.
- C. Clear penetrating sealers.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 30 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with concrete floor placement and concrete floor curing.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.6 FIELD CONDITIONS

- A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.
- B. Do not finish floors until interior heating system is operational.
- C. Maintain ambient temperature of 50 degrees F minimum.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a two-year period commencing on the Date of Substantial Completion.

PART 2 - PRODUCTS**2.1 COATINGS**

- A. Clear Coating: Clear coating recommended by manufacturer for finishing concrete floors and slabs.
 - 1. Type: High solids polyurethane; two-component.
 - 2. Gloss: High gloss.
 - 3. Color(s): As indicated on drawings.
 - 4. Products:
 - a. SureCrete Design Products; DK 400: www.surecretedesign.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

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- A. Verify that floor surfaces are acceptable to receive the work of this section.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.2 GENERAL

- A. Apply materials in accordance with manufacturer's instructions.

3.3 COATING APPLICATION

- A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- C. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

END OF SECTION 03 35 11

SECTION 039250 CONCRETE REPAIR MORTARS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Portland cement-based structural repair mortar with integral corrosion inhibitor suitable for overlays and full depth repairs.
- B. Trowel-grade concrete repair mortar for 1/4" to 2" depth repairs.

1.2 RELATED REQUIREMENTS

- A. Drawings, general provisions of the Contract, and other related construction documents such as Division 01 specifications apply to this Section.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 30 30 - Cast-in-Place Concrete
- D. Section 03 01 00 – Maintenance of Concrete

1.3 REFERENCES

- A. ASTM C 39, Compressive Strength of Cylindrical Concrete Specimens
- B. ASTM C 293, Flexural Strength of Concrete
- C. ASTM C 469, Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
- D. ASTM C 157, Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- E. ASTM C 496, Splitting Tensile Strength of Cylindrical Concrete Specimens
- F. ASTM D 4541, Pull-Off Strength of Coatings Using Portable Adhesion Testers
- G. ASTM C 309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- H. ICRI Technical Guideline No. 03732 Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
- I. ICRI Technical Guideline No. 03730 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used. Include manufacturer's Material Safety Data Sheets.
- B. Qualification Data: For Installer.
- C. Shop Drawing of interior slab plan indicating slopes, elevation points, dimensions, construction joints, transition and edge details, transition between concrete repair mortar, existing slabs and new concrete slabs, reinforcement layout, location of items to be embedded, etc.

1.5 WARRANTY

- A. Manufacturer's Warranty; Submit, for Owners acceptance, manufacturer's EXTENDED warranty documents.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: The manufacturer shall be a company with at least five years experience and regularly engaged in the manufacture and marketing of

products specified herein.

- B. Installation of the ARDEX product must be completed by an approved Ardex Level Master Elite installer qualified to provide extended warranties using mixing equipment and tools approved by the manufacturer. Please contact ARDEX Engineered Cements (724) 203-5000 for a list of recommended installers.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products in original packaging, labeled with product identification, manufacturer, batch number and shelf life.
- B. Store products in a dry area with temperature maintained between 50° and 85° F (10° and 29° C) and Protect from direct sunlight.
- C. Handle products in accordance with manufacturer's printed recommendations.

1.8 PROJECT CONDITIONS

- A. Do not install material below 50° F (10° C) surface and air temperatures. These temperatures must also be maintained during and for 48 hours after the installation of products included in this section. Install quickly if substrate is warm and follow warm weather instructions available from the Ardex Technical Service Department.

PART 2 - PRODUCTS

2.1 REPAIR MORTAR

- A. Portland cement-based structural repair mortar with built in corrosion inhibitor for horizontal,
 - 1. vertical, and overhead applications for exterior and interior concrete above, on or below grade.
- B. Manufacturers:
 - 1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
 - 2. The QUIKRETE Companies: www.quikrete.com/#sle.
 - 3. W. R. Meadows, Inc: www.wrmeadows.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Basis of Design:
 - 1. Full depth repairs: Ardex "FP", Manufactured by Ardex Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA 724-203-5000.
 - a. Performance and Physical Properties: Meet or exceed the following values for material cured at 70° F (20° C) and 50% relative humidity:
 - 1) Application: Trowel.
 - (a) Working Time: 20 - 40 minutes.
 - (b) Compressive Strength: 4800 at 7 days, 6000 psi at 28 days, ASTM C39.
 - (c) Flexural Strength: 700 psi at 7 days, 750 psi at 28 days, ASTM C293.
 - (d) Modulus of Elasticity in Compression: 3.9 x 106 psi at 28 days, ASTM C469, modified.
 - (e) Splitting Tensile Strength: 400 psi at 7 days, 600 psi at 28 days, ASTM C496.
 - (f) Direct Tensile Bond: 210 psi at 28 days, ASTM D4541
 - (g) Color: Concrete gray.
 - (h) Combustibility: Non-combustible, both before and after use.
 - 2) At areas with exposed rebar sections, apply anti-corrosion inhibitor prior to installation of repair mortar.
 - 2. Trowel-grade horizontal concrete repair mortar: Ardex "ERM" Manufactured by

ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA 724-203-5000.

- a. Performance and Physical Properties: Meet or exceed the following values for material cured at 73° F (23° C) and 50 percent relative humidity:
 - 1) Application: Trowel.
 - 2) Working Time: 25 - 45 minutes.
 - 3) Compressive Strength: 7,000 psi (48.3MPa) at 7 days, 8200 psi (56.58 MPa) at 28 days, ASTM C109.
 - 4) Flexural Strength: 1,200 psi (8.3 MPa) at 7 days, 1,500 psi (10.3 MPa) at 28 days, ASTM C78.
 - 5) Modulus of Elasticity in Compression: 3.67×10^6 psi at 28 days, ASTM C469, modified.
 - 6) Shrinkage: less than 0.06% at 7 days, less than 0.08% at 28 days, ASTM C157, air cured.
 - 7) Rapid Chloride Permeability: 820 Coulombs, at 28 days, ASTM C1202.
 - 8) Low -slump, non-sagging.
 - 9) Color: Concrete gray.
 - 10) Combustibility: Non-combustible, both before and after use.
3. Bonding & Anti-Corrosion Agent: Ardex "Baca" or equal.
 - a. Performance and Physical Properties:
 - 1) ASTM C882 Bond Strength:
 - (a) 1,800 at 2 hours (127 kg/cm²)
 - (b) 2,100 at 24 hours (148 kg/cm²)
 - 2) Two component, Portland cement/epoxy-based, brush or spray applied coating
 - b. Substrate Preparation:
 - 1) Prior to proceeding with any repair, please refer to the International Concrete Repair Institute's ICRI 03730 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion; ICRI 03732 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays; and the American Concrete Institute's ACI 546R-04 Concrete Repair Guide for general guidelines for concrete repair. Please also refer to the mortar or repair manufacturer's specific recommendations for substrate preparation.
 - 2) All substrates must be solid, thoroughly clean and free of oil, wax, grease, asphalt, existing patching materials, curing and sealing compounds, and any contaminant that might act as a bond breaker. Over watered, frozen or otherwise weak concrete surfaces must also be cleaned down to sound, solid concrete by mechanical methods such as scarifying or similar in accordance with ICRI 03732 to create an exposed aggregate surface with a minimum surface profile of approximately 1/16" (1.6 mm). Acid etching, solvents, sweeping compounds and sanding are not acceptable means of preparing the substrate.
 - 3) When reinforcing steel is exposed for protection, prepare the concrete such that a minimum 3/4" (19 mm) clearance is achieved under the reinforcement to ensure sufficient placement of anti-corrosion agent when brushed under steel. Remove all rust or active corrosion agents using sandblasting or mechanical wire brushing to produce a white metal

finish. Make sure surfaces are clean, dry and free of all contaminants.
Apply immediately to clean metal to avoid new corrosion.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General: Prepare substrate in accordance with manufacturer's instructions. Prior to proceeding with any repair, please refer to the International Concrete Repair Institute's ICRI 03730 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion; ICRI 03732 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays; and the American Concrete Institute's ACI 546R-04 Concrete Repair Guide for general guidelines for concrete repair.
1. All concrete and masonry substrates must be sound, solid, dry, and completely free of all oil, grease, dirt, curing compounds and any substance that might act as a bond breaker.
 2. Overwatered, frozen or otherwise weak concrete surfaces must also be cleaned down to sound, solid concrete by mechanical methods such as scarifying, scabbling or similar in accordance with ICRI 03732 before priming. Acid etching and the use of sweeping compounds and solvents are not acceptable.
 3. At areas requiring more than 2" of concrete repair mortar, the repair area must be saw cut in a basic rectangular shape at least 1 1/2" in depth. The cuts should be made at 90° angle, and should be slightly keyed. Chip out the concrete inside the cuts to a minimum depth of 1 1/2" until the area is squared or box shape.
 4. At areas requiring less than 2" of concrete repair mortar, the repair area must be saw cut in a basic rectangular shape at least 1/4" (6 mm) in depth. The cuts should be made at 90° angle, and should be slightly keyed. Chip out the concrete inside the cuts to a minimum depth of 1/4" (6 mm) until the area is squared or box shape.
 5. Mechanically prepare surface to obtain an exposed aggregate surface with a minimum surface profile of approximately 1/16" (1.5 mm).
 6. For cases with exposed reinforcing steel, mechanically clean the steel to remove all rust and any other contaminants in accordance with ICRI 03730. Prime the steel with "Ardex Bonding & Anti-Corrosion Agent" or equal prior to proceeding with repair. For further details, please refer to the Ardex Technical brochure.
 - a. Joint Preparation
 - 1) Moving Joints and Cracks - honor all expansion and isolation joints up through the concrete repair mortar. A flexible sealing compound suitable for the application may be installed. Ardex "Ardiseal Rapid Plus" or equal may be installed for interior applications only.
 - (a) Saw Cuts and Dormant Cracks - greater than 1/16" (1.6mm) should be filled with Ardex "Ardfix" or equal joint filler prior to installing Ardex "FP".

3.2 INSTALLATION OF REPAIR MORTARS:

- A. Examine substrates and conditions under which materials will be installed. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Coordinate installation with adjacent work to ensure proper sequence of construction. Protect adjacent areas from contact due to mixing and handling of

materials.

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- C. Mixing: Comply with manufacturer's printed instructions and the following.
1. Precondition components to temperature of 70° plus or minus 5° F (21° plus or minus 2.5° C) prior to mixing.
 2. Pre-dampen the inside of a pail or inside of a clean mortar mixer, and remove any excess water.
 3. Add 6.5 pints (3.08 L) of clean potable water, and then add one-third of an 80-pound (36.4 kg) bag. Once this is blended in, add the next third and so on until all of the material is added.
 4. Mix using a 1/2" to 3/4" (12 to 19 mm) low speed heavy-duty mixing drill with a heavy gauge square box (butterfly) mixing paddle. Forced action mortar mixers are also suitable. Mix to a uniform, lump-free consistency. For both mixing methods, avoid over mixing, which may entrap air. If additional water is required, you may add up to 8 oz. (0.24L) of additional mix water per bag. Do not overwater.
- D. Application: Comply with manufacturer's printed instructions and the following.
1. Do not apply in freezing conditions or during precipitation.
 2. Comply with manufacturer's guides for hot and cold weather application.
 3. Dampen substrate to fill concrete pores with water. Remove ponding, glistening, or surface water (saturated surface dry). If Ardex Bonding & Anti-Corrosion Agent is specified as a primer, follow the application instructions in the ARDEX Technical Brochure.
 4. When overlaying, apply scrub coat of repair mortar into substrate to ensure intimate contact and establish bond. Apply Ardex "FP" while scrub coat is wet. Consolidate and trowel to the desired finish.
 5. When pouring into closed forms, the repairs can be vibrated to ensure full contact and to establish bond with the substrate, as well as ensure proper consolidation. Avoid over- vibration.
 6. Steel trowel the mortar to the desired finish once it takes its initial set.
 7. Ardex "FP" can be installed from a minimum of 1 1/2" up to 8" neat (38mm to 20.3 cm).
- E. See Slab Plan Sheet A-102 for transition between trowel grade and full depth repair mortar. Blend mortar per manufacturers instructions. Also see Structural Foundation Plan for area to receive rebar.
- F. Any exposed rebar to receive anti-corrosion agent.
- G. Curing:
1. Keep surface damp for 48 hours with continuous light water-fogging or curing blanket.
 2. If no coating or sealer is to be applied, a water-based curing compound meeting ASTM C309 may be used. Do not use solvent-based curing compounds.
 3. Allow to cure a minimum 72 hours before applying any final coatings or sealers.
- H. Cleaning: Remove excess material before material cures. If material has cured, remove using mechanical methods that will not damage substrate.

END OF SECTION 03 92 50

SECTION 051200 STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural shapes.
2. Channels and angles.
3. Hollow structural sections.
4. Structural pipe.
5. Structural plates and bars.
6. Floor plates.
7. Fasteners, connectors, and anchors.
8. Grout.

1.2 REFERENCES

A. American Institute of Steel Construction:

1. AISC Steel Construction Manual (15th Edition).

B. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
4. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
7. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
8. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
10. ASTM A588 - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4-in. (100-mm) Thick.

11. ASTM A618 - Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
12. ASTM A786 - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
13. ASTM A847 - Standard Specification for Cold-Formed Welded and Seamless High Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
14. ASTM A992 - Standard Specification for Structural Steel Shapes.
15. ASTM F436 - Standard Specification for Hardened Steel Washers.
16. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

C. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.

D. Research Council on Structural Connections:

1. RCSC - Specification for Structural Joints Using ASTM A325 or A490 Bolts.

E. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 3 - Power Tool Cleaning.

1.3 SUBMITTALS

A. Shop Drawings:

1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
2. Connections.
3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

B. Manufacturer's Mill Certificate: Certify products meet or exceed specified requirements.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

D. Fabricator: Certificate of Compliance.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the following:

1. AISC Code of Standard Practice for Steel Buildings and Bridges.

B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

- A. Welders and Welding Procedures: AWS D1.1 qualified within previous 12 months.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

- A. Channels and Angles: ASTM A36.
- B. Round Hollow Structural Sections: ASTM A500, Grade B.
- C. Square and Rectangular Hollow Structural Sections: ASTM A500, Grade B.
- D. Structural Pipe: ASTM A53, Grade B.
- E. Structural Plates and Bars: ASTM A36.

2.2 FASTENERS, CONNECTORS, AND ANCHORS

- A. Bolts: ASTM A307; Grade A.
 - 1. Finish: Hot dipped galvanized U.O.N.
 - 2. Use Type 3 bolts for corrosion resistant weathering steel.
- B. High Strength Bolts: ASTM A325; Type 1.
 - 1. Finish: Hot dipped galvanized U.O.N.
- C. Nuts: ASTM A563 heavy hex type.
 - 1. Finish: Hot dipped galvanized U.O.N.
 - 2. Use Type 3 washers for corrosion resistant weathering steel.
- D. Washers: ASTM F436; Type 1, circular.
 - 1. Finish: Hot dipped galvanized U.O.N.
- E. Anchor Rods: ASTM F1554.
 - 1. Plate Washers: ASTM A36.
- F. Threaded Rods: ASTM A36.
 - 1. Finish: Hot dipped galvanized U.O.N. Rods used for temporary shoring may be unfinished.

2.3 WELDING MATERIALS

- A. Welding Materials: AWS D1.1; type required for materials being welded.

2.4 ACCESSORIES

- A. Shop and Touch-Up Primer: SSPC Paint 23.
- B. Teflon Bearing Pads: Voss VSB Unfilled PTFE sliding pads or approved equal.

2.5 FABRICATION

- A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- B. Fabricate connections for bolt, nut, and washer connectors.

- C. Develop required camber for members.

2.6 FINISH

- A. Prepare structural component surfaces in accordance with SSPC SP 3. Structural steel used for temporary shoring purposes do not require surface finishes.
- B. Shop prime structural steel members. Do not prime surfaces that will be field welded or are composed of weathering steel.

2.7 SOURCE QUALITY CONTROL AND TESTS

- A. Shop test bolted and welded connections as specified for field quality control tests.
- B. Submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
 - 1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify bearing surfaces are at correct elevation.
- B. Verify anchors rods are set in correct locations and arrangements with correct exposure for steel attachment.

3.2 PREPARATION

- A. Furnish templates for installation of anchor rods and embedments in concrete and masonry work.

3.3 ERECTION

- A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.
- B. Field weld components indicated on Drawings.
- C. Field connect members with threaded fasteners; torque to required resistance tighten to snug tight for bearing type connections.
- D. Do not field cut or alter structural members without approval of University's Representative.
- E. After erection, touch up welds and abrasions to match shop finishes.

3.4 FIELD QUALITY CONTROL

- A. The following tests shall be provided by a certified Special Inspector approved by the Owner and shall be in accordance with Section 1703.3 and Table 1704.3 of the 2022 CBC.
 - 1. Bolted Connections: Inspect in accordance with AISC specifications.
 - a. Visually inspect all bolted connections.
 - b. For Direct Tension Indicators, comply with requirements of ASTM F959. Verify that gaps are less than gaps specified in Table 2.

2. Welding: Inspect welds in accordance with AWS D1.1
 - a. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 - b. Visually inspect all welds.
 - c. Periodic Special Inspection shall be acceptable for single-pass fillet welds not exceeding 5/16 inch provided the welding procedures and qualifications of welders are verified prior to start of work.
3. Correct defective bolted connections and welds.

END OF SECTION 05 12 00

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SECTION 053123 STEEL ROOF DECKING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 - Specification sections, apply to work of this section.

1.2 SCOPE OF WORK

- A. Supplier: The steel deck supplier shall furnish all steel deck materials and accessories indicated on the Architectural, Structural, and Mechanical Drawings required to produce a complete job including but not necessarily limited to deck units, cover plates, steel deck edge closures, cell closures, cant strips, sump pans, and all related accessories.
- B. Erector: The Subcontractor responsible for erecting the steel deck shall provide all labor and equipment as required to place all steel deck components and accessories as described above.

1.3 QUALIFICATIONS

- A. The steel deck supplier shall be a manufacturer with a minimum of two years successful experience and with a minimum of two successful jobs of a comparable size and scope to this project.

1.4 QUALITY ASSURANCE

The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

- A. Codes and Standards: Comply with provisions of the following codes and standards except as otherwise indicated or specified:
 - 1. "Design Manual for Composite Decks, Form Decks, and Roof Decks", as published by the Steel Deck Institute (SDI).
 - 2. "Specification for the Design of Cold Formed Steel Structural Members", as published by the American Iron and Steel Institute (AISI).
 - 3. "Structural Welding Code – Sheet Steel", D1.3 as published by the American Welding Society (AWS).
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with AWS procedures.
- C. Underwriters Laboratories Classifications:

1. Provide steel deck units which are listed and conform to Underwriters Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific fire-resistant system detailed.
2. Provide units and construction meeting the requirements of applicable Construction No. as listed in the 2000 UL "Roofing Materials & Systems Directory" under Roof Deck Constructions (TGKX) and rated as a Class assembly. Each deck unit shall bear the UL label and marking for specific wind-rated system detailed.
- D. Factory Mutual Listing: Provide steel roof deck units which have been evaluated by Factory Mutual Research Corporation and are listed as an approved product in "Factory Mutual Research Approval Guide 2006- Building Materials".

1.5 SUBMITTALS

- A. Product Certification: Submit manufacturer's specifications and installation instructions for each type of deck specified. Also submit a certificate of product compliance with SDI Standards as specified.
- B. Shop Drawings: Submit detailed shop drawings showing type of deck, complete layout, attachment details, closures, edge strips, supplementary framing, and all other accessories.
- C. Insurance Certification: Assist Architect and Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire, windstorm, and extended coverage insurance.
- D. Welding Certificates: Submit Copies of certificates for welding procedures and personnel.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. See General Notes on the drawings for the location, depth of deck, design thickness, and type of deck required.
- B. Acoustic Steel Roof Deck Units:
 1. Single-Pan Units: Single-pan fluted units with vertical webs perforated sufficiently to meet the following minimum sound absorption criteria in the table below. The steel thickness, depth and width shall be as indicated on the drawings. Provide mineral fiber acoustical insulation strips, encapsulated in clear PVC plastic that is between 0.5 and 3.0 mil thick for moisture protection, with profile to fit void space between vertical ribs.

Frequency (HZ)
Deck Type

125 250 500 1000 2000 4000

1 ½" - WR	.44	.93	1.06	.94	.54	.23
3" - DR	.53	1.00	1.01	.87	.44	.24
"specify deck"	.30	.60	1.18	.98	1.00	.91

WR= Wide Rib Deck per SDI nomenclature DR= Deep Rib Deck
per SDI nomenclature

2. Double-Pan Cellular Units: Composite units consisting of upper fluted-section combined with lower flat plate section having interlocking side laps and perforations in the lower flat plate section sufficient to meet the following minimum sound absorption criteria in the table below. The steel thickness, depth and width shall be as indicated on the drawings. Provide mineral fiber acoustical insulation strips, encapsulated in clear PVC plastic that is between 0.5 and 3.0 mil thick for moisture protection, with profile to fit void space of each cell.

Frequency (HZ)

Deck Type	125	250	500	1000	2000	4000
1 ½" - WR	.38	.47	.63	.84	.74	.48
3" - DR	.44	.56	.95	.88	.72	.47
"specify deck"	.30	.60	1.18	.98	1.00	.91

WR= Wide Rib Deck per SDI nomenclature DR= Deep Rib Deck per
SDI nomenclature

C. Acceptable manufacturers

include: ASC Steel Deck. Canam
Group. Steel Dynamics
Cordeck
Epic Metals Corp. Loadmasters Systems, Inc.
Marylyn Steel
Valley Joist, Inc.
Verco Manufacturing Co. Vulcraft/Div.
Nucor Corp. Wheeling
Corrugating Co.

Other manufacturers may be used only with Architect/Engineer approval.

2.2 GRADES OF STEEL

- A. Steel deck shall be manufactured from steel conforming to ASTM A1008 Grades C, D, or E for painted deck or A653, Structural Steel Grade for galvanized deck or Engineer approved equal, having a minimum yield strength of 33,000 PSI.

2.3 FINISH

- A. Galvanizing: Steel deck shall be galvanized with a protective zinc coating conforming to ASTM A653 G90.
- B. Painting: Shop prime deck with gray or white baked-on, lead- and chromate-free rust inhibitive primer complying with performance requirements of FS TT-P-664. See Architect's drawings and painting specifications for steel deck finish paint requirements.
- C. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Department of Defense Specifications DOD-P-21035.

2.4 ROOF DECK ACCESSORIES

- A. Provide minimum 20 gauge ridge and valley plates, minimum 20 gauge cant strips, minimum 14 gauge sump pans, minimum 20 gauge inside or outside closure channels, angles or plates, minimum 20 gauge butt strips at change of deck directions, and minimum 20 gauge filler sheets.

2.5 MECHANICAL FASTENERS

- A. Powder-Actuated or Pneumatically Driven Pins: Provide corrosion-resistant, powder- actuated or pneumatically driven fasteners manufactured from steel conforming to AISI 1060 or 1061 steel, austempered to a core hardness of 52 to 58 Rockwell C. Fasteners shall have a knurled shank and shall be zinc-plated in accordance with ASTM B633, Sc. I, Type III.

Subject to compliance with requirements, provide products of one of the following

manufacturers: Hilti, Inc.
ITWBuildex Pneutek, Inc.

- B. Self-Drilling Screw Fasteners: Provide corrosion-resistant, hexagonal head, steel self drilling screws, austempered to a core hardness of Rockwell C 50.

Subject to compliance with requirements, provide products of one of the following

manufacturers: ITWBuildex
Grabber Construction Products
SFS Intec Fastening Systems, Inc., Wyomissing Textron Fastening
Systems

2.6 SIDE-LAP FASTENERS:

- A. Provide Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

2.7 FABRICATION

- A. General: Fabricate deck panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck", in SDI Publication No. 29, and the following.
- B. Steel Deck Spans: Where possible, all steel deck shall extend over three or more supports. Single span deck is prohibited.

2.8 ROOF OPENINGS

- A. Provide a 20 gage galvanized flat plate to reinforce openings in roof deck that are greater than 6" and less than 10" in any one direction.

PART 3 - EXECUTION

3.1 INSTALLATION

- 1. General: Install deck units and accessories in accordance with manufacturers recommendations and approved shop drawings, and as specified herein:
 - 2. Place deck units on supporting framework and adjust to final position with accurately aligned side laps and ends bearing 2" minimum on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks. Place the end joint over a chord angle for deck bearing on steel bar joists.
 - 3. Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.
 - 4. Place deck units flat and square (relative to supporting members), secured to adjacent framing without warp or excessive deflection.
 - 5. Do not place deck units on concrete supporting structure until concrete has cured and is dry.
 - 6. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
 - 7. Do not use roof deck units for storage or working platforms until permanently secured.
- B. Attachment of Roof Deck:
- 1. The method of attachment, attachment pattern, and side lap fastener type and spacing shall be as shown on the drawings and comply with the requirements noted below.
 - 2. Method of Attachment: The attachment method noted in the drawings shall comply with the applicable requirements below.

- a. Welding: Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work. Weld metal shall penetrate all layers of deck material at end laps and side joints and shall have good fusion to the supporting member. Welding washers shall be used only when welding steel deck less than 0.028" thickness. The diameter of the puddle weld on the supporting member shall be, at a minimum, the diameter stated in the drawings but no less than 1/2 inch.
 - b. Powder-Actuated or Pneumatically Driven Pins: An operator licensed by the pin manufacturer shall install all pins. Comply with the manufacturer's requirements to install the pins through all layers of the deck material and the manufacturer's required embedment into the supporting member.
 - c. Self-Drilling Fasteners: Comply with the manufacturer's requirements to install the screws through all layers of the deck material and the manufacturer's required embedment into the supporting member.
- 3. Side Lap Fastening: Unless required otherwise by provisions of this specification, side laps of adjacent units shall be fastened by #10 (min.) TEK screws so that spacing between supports and fasteners does not exceed the value prescribed on the drawings. Button Punching is not allowable as a side-lap fastener.
 - 4. End Bearing: Provide a minimum end bearing of 2" over supports.
 - 5. End Joints: End joints of sheets shall be lapped 2" minimum over supports. Decks that slope 1/4 inch or more in 12 inches in the long direction shall be erected beginning at the low side to insure that end laps are shingle fashion.
 - 6. Underwriters Laboratories Wind Uplift Classification Requirements: Unless a more stringent attachment requirement is specified elsewhere in this specification or on the drawings, roof deck units shall be attached to the supporting structure as required by the Construction Number specified elsewhere in this section.
 - 7. Attachment to Girders: At locations noted in the drawings, attach the deck to steel members that are parallel to the deck flutes in accordance with the requirements noted in the drawings.
- C. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking.
 - D. Reinforcement at Openings: Roof openings less than 6" square or diameter require no reinforcement. Openings 6" to 10" inclusive shall be reinforced with a 20 gauge galvanized plate welded to the deck at each corner and 6" maximum centers with a 5/8" diameter puddle weld or sheet metal screws. For openings greater than 10"

in diameter or width, refer to the drawings and structural steel specifications for additional framing to support the deck around the opening.

- E. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld in each corner.
- F. Joint Covers: Provide steel joint covers at changes in direction of deck units, except where taped joints are specified.
- G. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

3.2 TOUCH-UP PAINTING

- A. After deck installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members.
- B. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.
- C. Touch-up painted surfaces with same type of shop paint used on adjacent surfaces.
- D. In areas where shop-painted surfaces are to be exposed, apply touch-up paint to blend into adjacent surfaces.

3.3 QUALITY ASSURANCE INSPECTION DURING CONSTRUCTION

- A. The method of attaching the deck to the frame is subject to inspection by the Owner's designated Testing Laboratory. The Contractor shall, at its own expense, remove work found to be defective and replace with new acceptable work.
- B. See Testing Laboratory Services of these Specifications for deck attachment inspection requirements.

END OF SECTION 05 31 23

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Load-bearing wall framing.
 - 2. Exterior non-load-bearing wall framing.
 - 3. Floor joist framing.
 - 4. Roof rafter framing.
 - 5. Ceiling joist framing.
 - 6. Soffit framing.
- B. Related Requirements:
 - 1. Section 05 50 00 Metal Fabrications

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed steel framing product and accessory.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
- C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips.
7. Miscellaneous structural clips and accessories.

D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AllSteel & Gypsum Products, Inc.
2. California Expanded Metal Products Company.
3. ClarkWestern Building Systems, Inc.
4. Consolidated Fabricators Corp., Building Products Division.
5. Craco Mfg., Inc.
6. Custom Stud Inc.
7. Design Shapes in Steel.
8. Dietrich Metal Framing; a Worthington Industries Company.
9. Formetal Co. Inc. (The).
10. MarinoWARE.
11. Nuconsteel; a Nucor Company.
12. Olmar Supply, Inc.
13. Quail Run Building Materials, Inc.
14. SCAFCO Corporation.
15. Southeastern Stud & Components, Inc.
16. State Building Products, Inc.
17. Steel Construction Systems.
18. Steel Network, Inc. (The).
19. Steel Structural Systems.
20. Steeler, Inc.
21. Super Stud Building Products, Inc.
22. Telling Industries, LLC.
23. United Metal Products, Inc.
24. United Steel Manufacturing.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 Quality Requirements to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Design Loads: As indicated.

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Load-Bearing Wall Framing: Horizontal deflection of $1/360$ of the wall height.
 - b. Interior Load-Bearing Wall Framing: Horizontal deflection of $1/360$ of the wall height under a horizontal load of 5 lbf/sq. ft. (239 Pa).
 - c. Exterior Non-Load-Bearing Framing: Horizontal deflection of $1/360$ of the wall height.
 - d. Floor Joist Framing: Vertical deflection of $1/360$ for live loads and $1/240$ for total loads of the span.
 - e. Roof Rafter Framing: Vertical deflection of $1/360$ of the horizontally projected span for live loads.
 - f. Ceiling Joist Framing: Vertical deflection of $1/360$ of the span for live loads and $1/240$ for total loads of the span.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of $1/2$ inch (13 mm)
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

- B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G60 (Z180), or equivalent .
- C. Steel Sheet for Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G60 (Z180).

2.4 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
 - 2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm)
 - 2. Flange Width: 1-1/4 inches (32 mm)
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
 - 2. Flange Width: 1-5/8 inches (41 mm).

2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
 - 2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm)
 - 2. Flange Width: 1-1/4 inches (32 mm)
- C. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. AllSteel & Gypsum Products, Inc.
- b. ClarkWestern Building Systems, Inc.
- c. Dietrich Metal Framing; a Worthington Industries company.
- d. MarinoWARE.
- e. SCAFCO Corporation.
- f. Steel Network, Inc. (The).
- g. Steeler, Inc.

- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm)
2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures.

- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 FLOOR JOIST FRAMING

- A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
2. Retain one flange width from "Flange Width" Subparagraph below. Flange widths may vary with application. Sequence corresponds to common flange width designators 162, 200, and 250.
3. Flange Width: 1-5/8 inches (41 mm) minimum.

- B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1-1/4 inches (32 mm) minimum.

2.7 ROOF-RAFTER FRAMING

- A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
2. Flange Width: 1-5/8 inches (41 mm) minimum.

2.8 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
 - 2. Flange Width: 1-5/8 inches (41 mm) minimum.

2.9 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm)
 - 2. Flange Width: 1-5/8 inches (41 mm) minimum.

2.10 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Gusset plates.
 - 8. Stud kickers and knee braces.
 - 9. Joist hangers and end closures.
 - 10. Hole reinforcing plates.
 - 11. Backer plates.

2.11 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.12 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.
- D. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.13 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
- 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
- C. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 1. Anchor Spacing: As shown on Drawings.
- B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch (3 mm) between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 1. Stud Spacing: As indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
 2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

- I. Install horizontal bridging in stud system, spaced vertically as indicated. Fasten at each stud intersection.
 - 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
 - 2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches (450 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

- a. Install solid blocking at centers indicated.
 - b. Retain type of bridging required from three "Bridging" subparagraphs below or revise to suit Project. Insert locations if more than one type of bridging is required. Insert minimum size of flat steel strap, such as 1-1/2 by 0.0329 inch (38 by 0.84 mm), if default size is required.
2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:
1. Joist Spacing: As indicated.
- D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated.
1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated. Fasten bridging at each joist intersection as follows:

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
 2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

Draft
(Not for Bidding)

**SECTION 055000 METAL
FABRICATIONS**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Anchors, bolts, and fastening devices.
2. Miscellaneous steel.

B. Related Sections. See Related Sections for additional requirements applicable to this Section (typical).

1. Section 05 12 00 – Structural Steel

1.2 REFERENCES

A. American Institute of Steel Construction (AISC):

1. Manual of Steel Construction – 15th Edition.

B. American Society for Testing and Materials (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
4. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
7. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
9. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
10. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.
11. ASTM A312 – Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
12. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
13. ASTM A366 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.

14. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
15. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
16. ASTM A992 – Standard Specification for Structural Steel Shapes.
17. ASTM F436 - Standard Specification for Hardened Steel Washers.
18. ASTM F594 - Standard Specification for Stainless Steel Nuts.
19. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

C. American National Standards Institute (ANSI):

1. ANSI B18.22.1 - Plain Washers.

D. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code – Steel.
2. AWS D1.2 - Structural Welding Code – Aluminum.
3. AWS D1.6 - Structural Welding Code - Stainless Steel.
4. AWS A2.0 - Standard Welding Symbols.

E. Society for Protective Coatings (SSPC):

1. SSPC SP-1 - Surface Preparation Specification No. 1 Solvent Cleaning.
2. SSPC SP-2 - Surface Preparation Specification No. 2 Hand Tool Cleaning.
3. SSPC SP-3 - Surface Preparation Specification No. 3 Power Tool Cleaning.
4. SSPC SP-6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
5. SSPC SP-10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning.

1.3 SUBMITTALS

- A. Prior to fabrication, submit to the ENGINEER shop drawings, erection or setting drawings, product data, etc, showing methods of assembly, anchorage and connection to other members. Indicate welded connections in accordance with AWS A2.0. Shop drawings are required for all items included under this Section.
- B. Metal fabrication submittals greater than 30 sheets will take longer than 30 days for review by the ENGINEER.
- C. Submit samples as requested by the ENGINEER during the course of construction.

1.4 QUALITY ASSURANCE

- A. Coordinate completely the work of this Section with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work before fabrication and installation of the items specified.
- B. Furnish to the pertinent trades all items that are to be built into the work of other Sections.
- C. Field welding shall be done by certified welders and shall be in accordance with the appropriate AWS Specification.

1. Qualify welders in accordance with the appropriate AWS for each process, position, and joint configuration.
2. WPS's for each joint type shall indicate proper AWS qualification and be available where welding is performed.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Delivery anchorage devices with setting drawings, templates and instructions for installation.
- C. Store delivered items off the ground and protected from dirt and weather.
- D. Repair items which have become damaged or corroded to the satisfaction of the ENGINEER prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel

1. Structural steel wide flange shapes: ASTM A992.
2. Other structural steel shapes, plates, bars and rods: ASTM A36.
3. Steel sheets: ASTM A36.
4. Welded and seamless steel pipe: ASTM A53, Type S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work.
5. Welded and seamless rectangular steel tubing: ASTM A500, Grade B.
6. Cast-in anchor bolts: ASTM F1554, Grade 36.
7. High strength bolts, nuts and washers for structural steel:
 - a. Elevated temperature exposures: ASTM A325, Type I.
 - b. General application: ASTM A325, Type I or II.
8. Headed Anchor Studs: Nelson Type H4L or S3L by Nelson Stud Welding Company or equal.
9. Welding Materials AWS D1.1.
10. Galvanizing:
 - a. General: ASTM A123.
 - b. Hardware: ASTM A153.
 - c. Assembled steel products: ASTM A123.
11. Shop and Touch-up Primer: SSPC Paint 15 Type I red oxide.

B. Anchors, Bolts, and Fastening Devices

1. Furnish anchors, bolts, fasteners, etc, as necessary for installation of the work or for securing the work of other Sections to in-place construction.

2. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Attach aluminum and stainless steel to concrete or masonry by means of stainless steel bolts. Attach iron or steel with steel bolts unless otherwise specifically noted.
3. Bolt heads and nuts shall be hex type unless noted otherwise.
4. For structural purposes, unless otherwise noted, drilled-in concrete anchors shall be adhesive type or expansion type anchor bolts. Drilled-in anchors shall have ICC certified permissible values.
 - a. Concrete adhesive anchors shall be a two-part stud and cartridge resin anchoring system certified for use in cracked concrete. Stud assembly spacing and minimum embedment shall be as shown on the Drawings. The assembly shall include all-thread anchor rod with nut and washer, or deformed reinforcing steel. Provide manufacturer's recommended drive units and adaptors for installing studs. Install anchors in full compliance with the manufacturer's recommendations. Adhesive anchors for use in concrete shall be Hilti HIT-RE 500-SD by Hilti, Inc., Tulsa, OK; Epcon G5 by ITW Red Head, Addison, Illinois; Simpson SET-3G by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or approved equal.
 - b. Concrete expansion anchors shall be wedge type anchors certified for use in cracked concrete. Type 316 stainless steel expansion anchors shall be used where they will be submerged or exposed to the weather or where stainless steel expansion anchors are required. Zinc plated carbon steel anchors shall be used at all other locations, unless noted otherwise. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-in behind the reinforcing steel within the concrete. Install anchors in full compliance with the manufacturer's recommendations. Expansion anchors for use in concrete shall be Hilti, Kwik-Bolt TZ-2 by Hilti, Inc., Tulsa, OK; Simpson Strong-Bolt Wedge Anchor for Cracked and Uncracked Concrete by Simpson Strong-Tie Company, Inc., Pleasanton, CA; Redhead Trubolt + Wedge Anchor by ITW Red Head, Addison, Illinois; or approved equal.
 - c. Masonry adhesive anchors shall be Hilti HIT HY 150 MAX by Hilti, Inc., Tulsa, OK; Simpson SET by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or approved equal.
 - d. Masonry expansion anchors shall be Hilti Kwik-Bolt 3 by Hilti, Inc., Tulsa, OK; Simpson Wedge-All Anchors by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or approved equal.
5. Headed anchor studs shall be flux ended, welded to plates or other embeds as shown on the Drawings. Studs shall be made from cold drawn steel Grades C-1010 through C-1020 per ASTM A108 and shall be welded per the manufacturer's recommendations. Headed anchor studs shall be Nelson Stud Welding Company, Loraine, OH - Type H4L or S3L, or equal.

2.2 FABRICATION

- A. Form all miscellaneous metal work true to detail, with clean, straight, sharply defined profiles, and smooth surfaces of uniform color and texture. Provide fabrications free from defects impairing strength or durability. Drill or punch holes and smooth edges.

Ease exposed edges to a small, uniform radius. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

- B. Supply components required for anchorage of fabrications. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.
- C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Continuously weld and grind smooth welds that will be exposed. Exposed joints shall be close fitting and jointed where least conspicuous. Conceal fastenings where practical. Punch or drill for temporary field connections and for attachment of the work of other trades.
- D. Welding of parts shall be in compliance with the latest edition of the AWS structural welding code for steel (D1.1); aluminum (D1.2) or stainless steel (D1.6) as appropriate, and shall only be done where shown, specified, or permitted by the ENGINEER. Welding shall be performed only by welders certified to perform the required welding in compliance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.
- E. Castings shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Thoroughly clean castings. Castings may be subjected to a hammer inspection in the field by the ENGINEER. All finished surfaces shown on the Drawings and/or specified herein shall be machined to a true plan surface allowing pieces to seat at all points without rocking. Make allowances in the patterns so that thicknesses specified or shown will not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. Provide facilities for weighing castings in the presence of the ENGINEER and show true weights, certified by the supplier.
- F. Shop painting will not be required for galvanized metal, stainless steel, aluminum, copper, brass and bronze unless specifically specified.
- G. Thoroughly clean steel fabrications of all loose mill scale, rust, grease or oil, moisture, dirt, or other foreign matter.
 - 1. Remove scale, rust and other deleterious materials before shop coat of paint is applied.
 - 2. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2, SSPC SP-3 or SSPC SP-6.
 - 3. Remove oil, grease and similar contaminants in accordance with SSPC SP-1.
- H. Fabricate miscellaneous aluminum shapes and plates as shown. Furnish welded and mitered angle frames and other fabrications complete with welded anchors attached. Structural shapes and extruded items shall comply with the dimensions on the Drawings within the tolerances published by the Aluminum Association. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration of exposed aluminum surfaces.

2.3 FINISHES

A. Steel

1. Items in areas which are not exposed to weather or moisture, shall have exposed surfaces painted with a shop coat of primer compatible with the finish coatings specified in Section 09 91 00, after fabrication but before shipping. Apply two shop coats of primer to surfaces that will be inaccessible after erection.
 - a. Remove scale, rust and other deleterious material before shop coat of paint is applied. Clean off heavy rust and loose mill scale in accordance with SSPC-2, SSPC-3 or SSPC-6. Remove oil, grease and similar contaminants in accordance with SSPC SP-1.
 - b. Immediately after surface preparation, brush or spray on metal primer paint, applied in accordance with manufacturer's instructions and at rate to provide a uniform dry film thickness of 3.0 mils per coat applied. Use painting methods which will result in full coverage of joints, corner, edges and all exposed surfaces.
 - c. As soon as possible after erection, touch up any scraped, abraded or unpainted surfaces using primer as specified for shop coats.
2. Items exposed to weather, submerged in water or subject to splashing, or located in corrosive environments shall be hot dip galvanized after fabrication unless otherwise noted on the Drawings or specified.
 - a. Following all manufacturing operations, items to be galvanized shall be thoroughly cleaned, pickled, fluxed and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz/sq ft of surface.
 - b. Where field welding of galvanized material is necessary, welds shall be wire brushed clean and immediately regalvanized in the field using galvanizing compound or coating. Materials shall comply with local regulations controlling use of volatile organic compounds.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install all items finished.
- B. Items to be attached to concrete after such work is completed shall be installed in compliance with the details shown. Furnish to appropriate trades all anchors, sockets, or fastenings required for securing work to other construction.
- C. Set metal work level, true to line and plumb as indicated.
- D. Weld field connections and grind smooth where practicable. Clean and strip primed, steel items to bare metal where site welding is required. Conceal fastenings where practicable.
 1. Weld only in accordance with approved WPS's which are to be available to welders and inspectors during the production process.
- E. Secure metal to wood with lag screws or bolts, of adequate size, with appropriate washers and nuts.

- F. Touch-up abrasions to finish or primer coatings immediately after erection and prior to both final coating and final acceptance.
- G. Break contact between dissimilar metals as shown on the Drawings or as specified in Paragraph 3.1H below.
- H. Field-apply coatings for installation of metal fabrications according to the following schedule. (For embedded items, coat the embed.)
 - 1. All steel surfaces in contact with exposed concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in compliance with the manufacturer's instructions prior to installation.
 - 2. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
 - 3. Where aluminum contacts concrete, apply a heavy coat of zinc chromate primer to the surface of the aluminum.
 - 4. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

3.2 FIELD QUALITY CONTROL - INSPECTION

- A. Notify the ENGINEER in writing 4 working days in advance of high strength bolting or field welding operations.
- B. High strength bolting will be inspected visually. All high strength bolts shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. Retighten rejected bolts or remove and provide new bolts. In cases of disputed bolt installations, the bolts in question shall be checked using a calibrated wrench certified by an independent testing laboratory approved by the ENGINEER. The certification shall be at no additional cost to the OWNER.
- C. Field welding will be inspected visually and by non-destructive testing by AWS certified welding inspectors provided by an Independent Testing Agency. This work will be paid for by the OWNER. Testing procedures will include ultrasonic testing. CONTRACTOR shall comply with all requests of inspectors to correct deficiencies.
- D. The fact that steel work has been accepted at the shop and mill will not prevent its final rejection at the site, before or after erection, if it is found to be defective.
- E. Remove rejected steel work from the site within 10 working days after notification of rejection.

END OF SECTION 05 50 00

SECTION 055010**ANCHOR BOLTS AND POWDER ACTUATED FASTENERS****PART 1 – GENERAL****1.1 SCOPE**

- A. This section specifies anchor bolts complete with washers and nuts as well as powder actuated fasteners.

1.2 QUALITY ASSURANCE**A. References**

1. The publications referred to hereinafter form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.
2. International Conference of Building Official (ICBO) Publications
3. CBC California Building Code, 2022 Edition
4. American Society for Testing and Materials (ASTM) Publications
5. ASTM A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
6. ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength
7. ASTM A320 Alloy Steel Bolting Materials for Low-Temperature Service
8. ASTM A1554 Standard Specification for Anchor Bolts

1.3 SUBMITTALS

- A. The Contractor shall submit information in accordance with Section 01 33 00 Submittal Procedures, to substantiate compliance with this specification. In addition, the following specific information shall be submitted.
- B. Data indicating load capacities.
- C. Chemical resistance.
- D. Temperature limitations.

- E. Installation instructions.
- F. Manufacturer's data and catalogue numbers.
- G. ICBO evaluation reports for expansion and adhesive type anchors as specified in Part 3.3 and 3.4 in this Section.
- H. Design calculation in accordance with Part 2 in this Section.

PART 2 – PRODUCTS

2.1 ANCHOR BOLTS

A. General

1. Anchor bolt holes in support framing shall be a maximum of 1/4" larger than the anchor bolt size specified.
2. All anchor bolts shall be cast in place anchor bolts unless otherwise specified on the plans.

B. Materials

1. Anchor bolt materials shall be as specified in Table A unless otherwise specified on the contract drawings.

TABLE A ANCHOR BOLT MATERIALS

Anchor Bolt Type	Carbon Steel Assemblies	Equipment Anchorage/Aluminum Assemblies/Stainless Steel Assemblies
Cast-in-Place Anchor Bolts	ASTM 1554 SST	ASTM A320 Type 316
Adhesive Anchors HAS Rod with HILTI HY 150, Simpson "SET 3G" or equal	ASTM A320, Type A307 HILTI-	ASTM A320, Type 304 SST, HILTI-HAS Rod with HILTI HY 150, Simpson "SET 3G", or equal
Expansion Anchors KWIK-BOLT TZ2, Simpson Strong Bolt 2, or equal	ASTM A320, Type A307 HILTI	ASTM A320, Type 304 SST HILTI KWIK-BOLT TZ2, Type 304 SST Simpson Strong Bolt 2, or equal

Headed Anchor Studs

Nelson Stud, or equal

Nelson Stud, or equal.

(Not for Bidding)

2.2 POWDER ACTUATED FASTENERS

A. General

1. All powder actuated fasteners shall be as manufactured by Hilti incorporated, Simpson Strong-Tie Co., or an approved equal. The approved equal shall be equal in materials, strength, and intended use. Reference shall be made to the Hilti 2001 "Product Technical Guide", or Simpson's SAS 2002 Technical Manual for additional information.

B. Materials

1. Powder actuated fasteners driven into steel base material shall be 0.145 inch-diameter shank. Length of fastener shall be as required to penetrate through the steel base material. Minimum edge distance to any connected part shall be 1/2 inch and minimum fastener spacing shall be 2 inch.
2. Powder actuated fasteners driven into aluminum base material shall be X-CR type with P8 washers. Length of fastener shall be as required to penetrate through the aluminum base material. Minimum edge distance to any connected part shall be 1/2 inch and minimum fastener spacing shall be 2 inch.
3. Powder actuated fasteners driven into concrete base material shall be 0.145 inch-diameter shank. Length of fastener shall be as required to penetrate 1-1/2 inch into the concrete base material. Minimum edge distance to any concrete material shall be 3-inch and minimum fastener spacing shall be 4-inch.
4. Powder actuated fasteners driven into concrete base material through metal deck shall be 0.145 inch-diameter shank. Length of fasteners shall be as required to penetrate 1 inch minimum into the concrete through the low flute. Fasteners shall be centered in the low flute. The minimum fastener spacing shall be 4-inch.
5. Where steel washers are indicated on the drawings, powder actuated fasteners shall be 0.145 inch-diameter shank with 3/4-inch minimum diameter premounted steel washers.

2.3 STEEL FASTENERS LUBRICANT (ANTI-SEIZING)

- A. Where stainless steel anchor bolts, adhesive anchors, and expansion anchors are used, the Contractor shall apply an anti-seizing lubricant to the threads prior to making up the connections. The lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. All stainless steel anchor bolts and fasteners shall be assembled with anti-seize compound.

3.2 CAST-IN-PLACE ANCHOR BOLTS

- A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. The surfaces of metalwork in contact with concrete shall be thoroughly cleaned.
- B. All anchor bolts shall not touch reinforcing steel. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on. At locations where anchor bolts are to be installed in existing concrete, adhesive anchors or expansion anchors shall be used as specified in subsection 3.3 and 3.4.

3.3 ADHESIVE ANCHORS

- A. Use of adhesive anchors shall be as shown on the contract drawings and shall be subject to the following conditions:
 - 1. Anchor diameter shall be per contract documents or per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
 - 2. Embedment depth shall be as specified on the contract drawings.
 - 3. All installation recommendations by the anchor system manufacturer shall be followed carefully, including, but not limited to, maximum hole diameter, minimum embedment, and minimum edge distance.
 - 4. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.

5 Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.

- 6. Anchor shall be left undisturbed and unloaded for full adhesive curing period.
- 7. Concrete temperature (not air temperature) shall be compatible with curing requirements of adhesives per adhesive manufacturer. Anchors shall not be placed in concrete below 25 degrees F.

8. The Contractor shall supply the Owner with the current ICBO evaluation report from the International Conference of Building Officials for the particular brand of adhesive anchors to be used.

3.4 EXPANSION ANCHORS

- A. Use of expansion anchors shall be as shown on the contract drawings and shall be subject to applicable conditions specified in Part 3.3 of this Section.
- B. The Contractor shall supply the Owner with the current ICBO evaluation report from the International Conference of Building Officials for the particular brand of expansion anchors to be used.

3.5 POWDER ACTUATED FASTENERS

- A. Powder actuated fasteners shall be provided and installed as specified on the contract drawings. Fastener installation shall be per the requirements of these specifications and the fastener manufacturer's recommendations. Use of powder actuated fasteners other than as shown on the contract drawings shall not occur unless specifically approved by the Owner.

END OF SECTION 05 50 10

SECTION 068316 FIBERGLASS REINFORCED PANELING**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fiberglass reinforced plastic panels.
- B. Trim.

1.02 REFERENCE STANDARDS

- A. 9 CFR 416.2 - Regulatory Requirements Under the Federal Meat Inspection Act and the Poultry Products Inspection Act, Part 416-Sanitation; current edition.
- B. ASTM D5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels; 2022.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Samples: Submit two samples 4 by 4 inch (____x____mm) in size illustrating material and surface design of panels.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store panels flat, indoors, on a clean, dry surface. Remove packaging and allow panels to acclimate to room temperature for 48 hours prior to installation.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Fiberglass Reinforced Plastic Panels:
 - 1. Marlite, Inc; _____: www.marlite.com/#sle.
 - 2. Nudo Products, Inc; FiberLite FRP: www.nudo.com/#sle.
 - 3. Panolam Industries International, Inc; _____: www.panolam.com/#sle.
 - 4. Or Equal.

2.02 PANEL SYSTEMS

- A. Wall Panels:
 - 1. Panel Size: 4 by 8 feet (1.2 by 2.4 m).
 - 2. Panel Thickness: 0.10 inch (2.5 mm).
 - 3. Surface Design: Smooth.
 - 4. Color: As selected by Architect.
 - 5. Attachment Method: Adhesive only, with trim and sealant in joints.

2.03 MATERIALS

- A. Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.
 - 1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
 - 2. Sanitation and Cleanability: Comply with 9 CFR 416.2.
- B. Trim: Vinyl; color coordinating with panel.
- C. Fasteners: Nylon rivets.
- D. Adhesive: Type recommended by panel manufacturer.
- E. Sealant: Type recommended by panel manufacturer; white.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions and substrate flatness before starting work.
- B. Verify that substrate conditions are ready to receive the work of this section.

3.02 INSTALLATION - WALLS

- A. Install panels in accordance with manufacturer's instructions.
- B. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.
- C. Pre-drill fastener holes in panels, 1/8 inch (3.2 mm) greater in diameter than fastener, spaced as indicated by panel manufacturer.
- D. Apply adhesive to the back side of the panel using trowel as recommended by adhesive manufacturer.
- E. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.
- F. Install panels with manufacturer's recommended gap for panel field and corner joints.
- G. Drive fasteners to provide snug fit, and do not over-tighten.
- H. Place trim on panel before fastening edges, as required.
- I. Fill channels in trim with sealant before attaching to panel.
- J. Install trim with adhesive and screws or nails, as required.
- K. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.

- L. Remove excess sealant after paneling is installed and prior to curing.

END OF SECTION 068316

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SECTION 072100 THERMAL INSULATION**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Batt insulation and vapor retarder in exterior wall, ceiling, and roof construction.
- B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

- A. Section 072600 - Vapor Retarders: Separate vapor retarder materials.

1.03 REFERENCE STANDARDS

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.
- B. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024c.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

1.05 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS**2.01 APPLICATIONS**

- A. Insulation in Metal Framed Walls: Batt insulation with integral vapor retarder.

2.02 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
 - 1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 2. Facing: Aluminum foil, flame spread 25 rated; one side.

2.03 ACCESSORIES

- A. Sheet Vapor Retarder: See Section 072600.
- B. Sheet Vapor Retarder: Black polyethylene film reinforced with glass fiber square mesh, _____ mil (_____ mm) thick.
- C. Interior Vapor Retarder: Modified polyethylene/polyacrylate (PE/PA) film reinforced with polyethylene terephthalate (PET) fibers, 12 mil, 0.012 inch (0.30 mm) thick.
 - 1. Width: 4.9 feet (1.5 m).
- D. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 - 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 - 2. Width: As required for application.
- E. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.
- F. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install with factory-applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Tape insulation batts in place.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- H. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over face of member.
- I. Tape seal tears or cuts in vapor retarder.
- J. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.
- K. Coordinate work of this section with requirements for vapor retarder, see Section 072600.

3.03 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

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SECTION 072500 WEATHER BARRIERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Building wrap.
 - 2. Flexible flashing.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- B. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- C. ASTM E1677 - Standard Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls; 2023.
- D. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
- B. Shop Drawings: Show details of building wrap at terminations, openings, and penetrations. Show details of flexible flashing applications.

1.05 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For water-resistive barrier and flexible flashing, from ICC-ES.

PART 2 PRODUCTS**2.01 WATER-RESISTIVE BARRIER**

- A. Building Wrap: ASTM E1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Henry Company Blueskin VP160 Self-Adhered Water Resistive Air Barrier, or approved equal.
 - 2. Water-Vapor Permeance: Not less than 20 perms per ASTM E96/E96M, Desiccant Method (Procedure A).
 - 3. Allowable UV Exposure Time: Not less than three months.
 - 4. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.02 FLEXIBLE FLASHING

- A. Rubberized-Asphalt Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.040 inch.
 - 1. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Primer for Flexible Flashing: Product recommended in writing by flexible flashing manufacturer for substrate.
- C. Nails and Staples: Product recommended in writing by flexible flashing manufacturer and complying with ASTM F 1667.
 - 1. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

PART 3 EXECUTION**3.01 WATER-RESISTIVE BARRIER INSTALLATION**

- A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.
- B. Cover sheathing with water-resistive barrier as follows:
 - 1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
 - 2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap unless otherwise indicated.
- C. Building Wrap: Comply with manufacturer's written instructions and warranty requirements.
 - 1. Seal seams, edges, fasteners, and penetrations with tape.

2. Extend into jambs of openings and seal corners with tape.

3.02 FLEXIBLE FLASHING INSTALLATION

- A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.
 1. Prime substrates as recommended by flashing manufacturer.
 2. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
 3. Lap flashing over water-resistive barrier at bottom and sides of openings.
 4. Lap water-resistive barrier over flashing at heads of openings.
 5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

END OF SECTION 072500

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SECTION 072600 VAPOR BARRIER**PART 1 – GENERAL****1.1 SUMMARY****A. Products Supplied Under This Section**

1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs
- RELATED SECTIONS
1. Section 03 30 00 Cast-in-place Concrete
2. Section 07 26 00 Vapor Retarders

1.2 REFERENCES**A. American Society for Testing and Materials (ASTM)**

1. ASTM E 1745-97 (2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
2. ASTM E 154-99 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
3. ASTM E 96-05 Standard Test Methods for Water Vapor Transmission of Materials
4. ASTM F 1249-06 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
5. ASTM E 1643-98 (2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

B. American Concrete Institute (ACI)

1. ACI 302.1R-04 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick

1.3 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures
- B. Product Data: Submit data indicating product characteristics and performance criteria.
- C. Samples: Submit material samples.
- D. Certificate: When requested, manufacturer shall provide a written document certifying material performance, batch number and ASTM testing report for the specific material to be delivered to the job site.

PART 2 – PRODUCTS**2.1 MATERIALS****A. Vapor Barrier must have all of the following qualities:**

1. Permeance of less than 0.01 Perms [grains/(ft²*hr * in.Hg)] per ASTM F 1249 or ASTM E 96
2. Maintain permeance of less than 0.01 Perms [grains/(ft²*hr * in.Hg)] after mandatory conditioning tests per ASTM E 154 Sections 8,11,12, and 13.
3. ASTM E 1745 Class A

- B. Vapor Barrier products:
 - 1. Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
 - 2. Or approved Equal that meets all of the performance requirements.

2.2 ACCESSORIES

- A. Seam Tape
 - 1. Tape must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower
- B. Vapor Proofing Mastic
 - 1. Mastic must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower
- C. Pipe Boots
 - 1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.
- D. Vapor Stakes
 - 1. Stakes must have the following qualities:
 - a. Density ASTM D 1505 0.0289 lb/in³
 - b. Specific Gravity ASTM D 792 0.0477

PART 3 – EXECUTION

3.1 PREPARATION

- A. Ensure that subsoil is approved by architect or geotechnical firm
 - 1. Level and tamp or roll aggregate, sand or tamped earth base.

3.2 INSTALLATION

- A. Install Vapor Barrier/Retarder:
 - 1. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643-04.
 - a. Unroll Vapor Barrier/Retarder with the longest dimension parallel with the direction of the pour.
 - b. Lap Vapor Barrier/Retarder over footings and seal to foundation walls.
 - 1. Seal to interior/perimeter footings using Vapor Proofing Mastic
 - c. Overlap joints 6 inches and seal with manufacturer's tape.
 - d. Seal all penetrations (including pipes) per manufacturer's instructions.
 - 1. Single pipe penetrations may be sealed using pipe boot constructed from the product
 - a) Cut a piece of Plastic, Vapor Barrier

width: minimum 12 inches

length: 1 and ½ times the circumference of the pipe

- b) with scissors, cut slits half the width of the film
- c) Wrap boot around pipe; tape onto pipe and completely tape the base to the Vapor Barrier/Retarder
- 2. Multiple pipe penetrations in close proximity and very small pipes may be sealed using Vapor Proofing Mastic

pipes

- a) Cut out a small area around pipes
- b) Cut a patch of Vapor Barrier/Retarder extending at least 6 inches past the cut out in all directions
- c) Cut X's or small circles in the patch and install over
- d) Overlap at least 6 inches and tape
- e) Build up 40-60 mils of mastic, or as needed to completely fill all voids between the pipe and Vapor Barrier/Retarder
- e. No penetration of the Vapor Barrier/Retarder is allowed except for reinforcing steel and permanent utilities.
- 1. In the case that forms must be used vapor stakes should be used to hold forms in place.
 - a) Penetrate plastic with stake
 - b) Treat stake as pipe penetration (see above section d. 2. a) – e))
 - c) leave stake permanently in concrete
 - d) Using a power saw, cut the stake off above the seal, but below the concrete's finished surface
 - e) The lower portion of the vapor stake remains in place, permanently plugging the penetration
- f. Repair damaged areas by cutting patches of Vapor Barrier/Retarder, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 07 26 00

SECTION 074113.16 STANDING-SEAM METAL ROOF PANELS**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. Section Includes: Standing-seam metal roof panels.

1.03 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- B. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products; 2018.
- C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2025.
- D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2024.
- E. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- G. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.
- H. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2025.
- I. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2025.
- J. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2023.
- K. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- L. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2025.

- M. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference; 1995 (Reapproved 2024).
- N. ASTM E1680 - Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems; 2016 (Reapproved 2022).
- O. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2024.
- P. CRRC-1 - CRRC-1 Roof Product Rating Program Manual; 2025.
- Q. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; Current Edition, Including All Revisions.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review structural loading limitations of deck, purlins and rafters during and after roofing.
 - 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 - 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 8. Review temporary protection requirements for metal panel systems during and after installation.
 - 9. Review procedures for repair of metal panels damaged after installation.
 - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.05 ACTION SUBMITTALS

- A. Product Data: For standing-seam metal roof panels. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

3. To coordinate with roof profile, show tapered panel layout, to accommodate roof curvature and general layout.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For standing-seam metal roof panels, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.09 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 1. Build mockup of typical roof area and eave, including fascia, and soffit as shown on Drawings; approximately 48 inches square by full thickness, including attachments, underlayment, and accessories.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.12 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Energy Performance:
 - 1. Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for low-slope roof products.
 - 2. Provide roof panels according to one of the following when tested according to CRRC-1:
 - a. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
 - b. Three-year, aged Solar Reflectance Index of not less than 64 when calculated in accordance with ASTM E1980.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft..
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 2.86 lbf/sq. ft..
- E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.
- F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F , ambient; 180 deg F , material surfaces.

2.02 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - a. Basis-of-Design: Morin - A Kingspan Group Company.
 - b. Comparable products by AEP Span.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 0.040 inch.
 - b. Exterior Finish: Three-coat fluoropolymer .
 - c. Color: As indicated by manufacturer's designations As selected by Architect from manufacturer's full range .
 3. Clips: Two-piece floating to accommodate thermal movement.
 - a. 0.0250-inch- thick, stainless steel sheet.
 4. Panel Coverage: 18 inches.
 5. Panel Height: 2 ½ inches.
 6. To coordinate with roof profile, provide tapered panels as required, of widths approximately 10 ½" min. to 18" max.

2.03 UNDERLAYMENT MATERIALS

- A. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.04 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Custom recessed system, as detailed. Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.
- E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.05 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.06 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin m
 2. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply
 3. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to
 4. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coa

5. FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer
6. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.03 INSTALLATION OF UNDERLAYMENT

- A. Underlayment: Manufacturer's Rubberized Asphalt Underlayment: ASTM D1970; minimum 40 mil thick polymer modified asphalt laminated to slip-resistant polyethylene film, self-adhering, formulated for extended high in-service temperatures up to 260 degrees F.
 1. Apply over the entire roof surface.
 2. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.04 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
 - 1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
 - 3. Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.
 - 4. Stainless Steel Panels: Use stainless steel fasteners.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 - 5. Watertight Installation:

- a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommended in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.
- G. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- H. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to formhems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- I. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- J. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
 2. Connect downspouts to underground drainage system indicated.
- K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.05 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

SECTION 074213 METAL WALL PANELS**PART 1 GENERAL****1.01 RELATED REQUIREMENTS**

- A. Section 054000 - Cold-Formed Metal Framing: Wall panel substrate.
- B. Section 072100 - Thermal Insulation.
- C. Section 072500 - Weather Barriers: Weather barrier under wall panels.
- D. Section 072700 - Air Barriers: Air barrier under wall panels.
- E. Section 079200 - Joint Sealants: Sealing joints between metal wall panel system and adjacent construction.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, _____, and methods of anchorage.
- D. Samples: Submit two samples of wall panel and soffit panel, 12 inches by 12 inches (305 mm by 305 mm) in size illustrating finish color, sheen, and texture.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.06 FIELD CONDITIONS

- A. Do not install wall panels when air temperature or relative humidity are outside manufacturer's limits.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Metal Wall Panels - Concealed Fasteners:
 - 1. Berridge Manufacturing Company; BR-12 Panel: www.berridge.com/#sle.
- B. Metal Soffit Panels:
 - 1. Berridge Manufacturing Company; Vee-Panel: www.berridge.com/#sle.

2.02 METAL WALL PANEL SYSTEM

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
 - 1. Provide exterior wall panels and soffit panels.
 - 2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
 - 3. Maximum Allowable Deflection of Panel: $L/180$ for length(L) of span.
 - 4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 - 6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 - 7. Corners: Factory-fabricated in one continuous piece with minimum 2-inch (51 mm) returns.
- B. Exterior Wall Panels:
 - 1. Profile: Horizontal; style as indicated.
 - 2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.

3. Panel Width: ____ inches (____ mm).
- C. Soffit Panels:
 1. Profile: Style as indicated, with venting provided.
 2. Material: Precoated steel sheet, 22 gauge, 0.0299 inch (0.76 mm) minimum thickness.
 3. Color: As selected by Architect from manufacturer's standard line.
 4. Color: As indicated.
- D. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
- E. Expansion Joints: Same material, thickness and finish as exterior sheets; ____ gauge, ____ inch (____ mm) thick; manufacturer's standard brake formed type, of profile to suit system.
- F. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
- G. Anchors: Galvanized steel.

2.03 MATERIALS

- A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, Structural Steel (SS) or Forming Steel (FS), with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.
- C. High Performance Organic Coating System: Multi-coat, high-durable polyester system; color as indicated on drawings.
 1. Systems:

2.05 ACCESSORIES

- A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
- B. Concealed Sealants: Non-curing butyl sealant or tape sealant, see Section 079200
- C. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
- D. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.
- E. Field Touch-up Paint: As recommended by panel manufacturer.
- F. Bituminous Paint: Asphalt base.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that building framing members are ready to receive panels.
- B. Verify weather barrier, see Section 072500, has been installed over wall panel substrate; see Section 054000.
- C. Verify air barrier, see Section 072700, has been installed over wall panel substrate; see Section 054000.

3.02 PREPARATION

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.
- B. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint; allow to dry prior to wall panel installation.
- C. Fasten panels to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Lap panel ends 2 inches (51 mm), minimum.
- F. Provide expansion and control joints where indicated.
- G. Use concealed fasteners unless otherwise indicated by Architect.
- H. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES

- A. Offset From True Alignment Between Adjacent Members Abutting or In Line: 1/16 inch (1.6 mm), maximum.
- B. Variation from Plane or Location As Indicated on Drawings: 1/4 inch (6.4 mm), maximum.

3.05 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Remove protective material from wall panel surfaces.
- C. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.06 PROTECTION

- A. Protect metal wall panels until completion of project.

- B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION 074213

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SECTION 076200**SHEET METAL FLASHING AND TRIM****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Sealants for joints within sheet metal fabrications.
- C. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.

1.03 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- C. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2024).
- D. CDA A4050 - Copper in Architecture - Handbook; Current Edition.
- E. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Fabricate and install roof edge flashing and copings capable of resisting forces required by CBC according to recommendations in FMG Loss Prevention Data Sheet 1-49.
- C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes of 120-deg F. ambient and 180-deg F material surfaces.

2.02 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239 inch) (0.61 mm) thick base metal.

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.
- F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.04 EXTERIOR PENETRATION FLASHING PANELS

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.05 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Primer: Zinc chromate type.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E. Plastic Cement: ASTM D4586/D4586M, Type I.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Seal metal joints watertight.

END OF SECTION 076200

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SECTION 078413 PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.

1.03 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
- B. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.07 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - 3. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 4. UL in its online directory "Product iQ."
 - 5. Intertek Group in its "Directory of Building Products."
 - 6. FM Approvals in its "Approval Guide."

2.02 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Manufacturers: Provide products indicated on Drawings. Where products are not indicated, subject to compliance with requirements, provide products by one of the following:
 - 1. 3M Fire Protection Products.
 - 2. Specified Technologies, Inc.
 - 3. Tremco, Inc.
 - 4. Or Approved Equal.
- C. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- D. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - 3. Those within the cavity of a wall.
 - 4. Floor, tub, or shower drains within a concealed space.
 - 5. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
- E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.
 - 4. Steel sleeves.

2.03 FILL MATERIALS

- A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- C. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- D. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

- E. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.
- F. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.
- G. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.
- H. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.
- I. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.
- J. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.
- K. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.
- L. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch diameter.
- M. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.
- N. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.04 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.

3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.05 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 JOINT FIRESTOPPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. DBMasterDate-12022024Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.
 - 2. Joints in smoke barriers.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- B. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.
- C. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2024.
- D. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.07 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article.
Provide rated systems complying with the following requirements:
 - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
- B. Joint firestopping shall comply with CALGreen Notes located on Sheet CP0.0.2 - Code Analysis.

2.02 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. 3M Fire Protection Products.
 - b. Hilti, Inc.
 - c. Nelson Firestop; a brand of Emerson Industrial Automation.
 - d. Specified Technologies, Inc.
 - e. Tremco, Inc.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. 3M Fire Protection Products.
 - b. Hilti, Inc.
 - c. Nelson Firestop; a brand of Emerson Industrial Automation.
 - d. Specified Technologies, Inc.
 - e. Tremco, Inc.
 - 2. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.
- D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.07 JOINT FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.
- B. Wall-to-Wall, Joint Firestopping Systems:
 - 1. UL-Classified Systems: WW- S-.
 - 2. Assembly Rating: As indicated.
 - 3. Nominal Joint Width: As indicated.
- C. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:
 - 1. UL-Classified Systems: HW- S- with suffixes indicated on Drawings.
 - 2. Assembly Rating: As indicated.
 - 3. Nominal Joint Width: As indicated.
- D. Bottom-of-Wall, Joint Firestopping Systems:
 - 1. UL-Classified Systems: BW- S- with suffixes indicated on Drawings.
 - 2. Assembly Rating: As indicated.
 - 3. Nominal Joint Width: As indicated.
- E. Perimeter Joint Firestopping Systems:
 - 1. UL-Classified Perimeter Fire-Containment Systems: CW- S- with suffixes indicated on Drawings.
 - 2. Integrity Rating: As indicated.
 - 3. Insulation Rating: As indicated.
 - 4. Linear Opening Width: As indicated, maximum.

END OF SECTION 078443

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SECTION 079200 JOINT SEALANTS**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

1.03 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2024.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- E. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).
- F. SWRI (VAL) - SWR Institute Validated Products Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.
 - 7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
 - 8. Sample product warranty.

9. Certification by manufacturer indicating that product complies with specification requirements.
 10. SWRI Validation: Provide currently available sealant product validations as listed by SWRI (VAL) for specified sealants.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
 - D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
 - E. Samples for Verification: Submit at least two physical samples for verification of color of each required sealant.
 - F. Manufacturer's Qualification Statement.
 - G. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

- A. Scope:
 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.
 - c. Joints between different exposed materials.
 - d. Other joints indicated below.
 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Interior wall gypsum board connection to adjacent materials
 - c. Gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - d. Other joints indicated below.
 3. Do not seal the following types of joints.
 - a. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
 - b. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - c. Joints where installation of sealant is specified in another section.
 - d. Joints between suspended panel ceilings/grid and walls.

- B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
- C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.

2.02 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.03 NONSAG JOINT SEALANTS

- A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 - 2. Color: Match adjacent finished surfaces.
- B. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: Match adjacent finished surfaces.
 - 4. Cure Type: Single-component, neutral moisture curing
 - 5. Service Temperature Range: Minus 65 to 180 degrees F (Minus 54 to 82 degrees C).
 - 6. Manufacturers:
 - a. Subject to compliance with requirements, provide products by Sika Corporation, Dow Chemical Company, , or Pccora Corporation.
- C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 2. Color: Match adjacent finished surfaces.

2.04 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 079200

SECTION 081113

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Fire-rated hollow metal doors and frames.
- C. Thermally insulated hollow metal doors with frames.

1.02 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware.
- B. Section 088000 - Glazing: Glass for doors and borrowed lites.
- C. Section 099113 - Exterior Painting: Field painting.
- D. Section 099123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. HMMA: Hollow Metal Manufacturers Association.
- C. NAAMM: National Association of Architectural Metal Manufacturers.
- D. NFPA: National Fire Protection Association.
- E. SDI: Steel Door Institute.
- F. UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2025.
- C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2024.
- D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.
- E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- F. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.

- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2024.
- I. 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; 2023.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- K. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- L. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- M. ITS (DIR) - Directory of Listed Products; Current Edition.
- N. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- O. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2024.
- P. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.
- Q. NAAMM HMMA 850 - Fire-Rated Hollow Metal Doors and Frames; 2014.
- R. NAAMM HMMA 860 - Guide Specifications for Hollow Metal Doors and Frames; 2018.
- S. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- T. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- U. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.
- V. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- W. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.
- X. UL (DIR) - Online Certifications Directory; Current Edition.
- Y. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- Z. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- AA. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C. Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
 - 3. Republic Doors, an Allegion brand; _____: www.republicdoor.com/#sle.
 - 4. Steelcraft, an Allegion brand; _____: www.allegion.com/#sle.
 - 5. Or equal..

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 - 4. Door Edge Profile: Manufacturers standard for application indicated.
 - 5. Typical Door Face Sheets: Flush.
 - 6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
 - 7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Hollow Metal Panels: Same construction, performance, and finish as doors.

- C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
 2. Door Core Material: Polyurethane, 1.8 lbs/cu ft minimum density.
 - a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
 3. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
 4. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
 5. Top Closures for Outswinging Doors: Flush with top of faces and edges.
 6. Door Face Sheets: Flush.
 7. Weatherstripping: Refer to Section 087100.
 8. Door Finish: Factory primed and field finished.
- C. Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.
 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 3. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
 4. Door Face Sheets: Flush.
 5. Door Finish: Factory primed and field finished.
- D. Fire-Rated Doors:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.

- d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.
- e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
- 2. Fire Rating: As indicated on drawings, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
- 3. Temperature-Rise Rating (TRR) Across Door Thickness: In accordance with local building code and authorities having jurisdiction.
- 4. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
- 5. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following;
 - a. Maximum Air Leakage: 3.0 cfm/sq ft (0.02 cu m/sec/sq m) of door opening at 0.10 inch w.g. (24.9 Pa) pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - b. Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
 - c. Label: Include the "S" label on fire-rating label of door.
- 6. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
- 7. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
- 8. Door Face Sheets: Flush.
- 9. Door Finish: Factory primed and field finished.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Full profile/continuously welded type.
 - 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvanized) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 - 2. Frame Finish: Factory primed and field finished.
 - 3. Weatherstripping: Separate, see Section 087100.
- D. Interior Door Frames, Non-Fire Rated: Face welded type.
 - 1. Frame Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
 - 2. Frame Finish: Factory primed and field finished.
- E. Door Frames, Fire-Rated: Face welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Frame Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
 - 3. Frame Finish: Factory primed and field finished.
- F. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Glazing: As specified in Section 088000, factory installed.
- B. Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.
 - 1. UL listed products in compliance with requirements of authorities having jurisdiction.
 - 2. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
 - 3. Material: Steel.
 - 4. Metal Finish: _____ Factory primed and field finished.
 - 5. Provide non-corroding fasteners at exterior locations.
- C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- D. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- E. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 087100.
 - 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- E. Comply with glazing installation requirements of Section 088000.
- F. Coordinate installation of electrical connections to electrical hardware items.
- G. Touch up damaged factory finishes.

3.03 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.

3.05 SCHEDULE

- A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION 081113

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SECTION 083113 ACCESS DOORS AND FRAMES**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SECTION INCLUDES

- A. Wall and ceiling mounted access units.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- C. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- D. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings of adjacent construction indicated, according to NFPA 252 or UL 10B.

2.02 ACCESS DOORS AND FRAMES

- A. Drywall Inlay with concealed flange and hinge.
- B. Manufacturers and models: unless otherwise noted on Drawings, at non- Fire Rated condition: WB RDW 410 Recessed Drywall Access Door by Williams Brothers Corporation of America, At Fire Rated condition: FR-DRW 860 Series.
 - 1. Or Approved Equal.
- C. Steel Sheet for Door: 14 gauge minimum.
- D. Frame Material: 16 gauge minimum, flange 16 ga. minimum 1" wide 24 gauge min.

- E. Door configuration: Recessed door panel prepared for installation of 5/8" gypsum wall board.
- F. Door size: as indicated on Drawings.
- G. Hinge: Fully-concealed, pivot-rod type hinge.
- H. Latch and Lock: Cam latch, screwdriver operated.
- I. Finish: manufacturer's factory primed white baked enamel, paintable.

2.03 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.04 FINISHES

- A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- B. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 1. Unless otherwise indicated in Drawings, field paint to match adjacent construction.
- C. Factory Finished: Apply manufacturer's standard baked enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.
 - 1. Color: as selected by Architect from full range of industry colors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to proceeding with this work.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

- D. Where access doors receive gypsum wallboard insert, install wallboard of the depth required for a flush finish. Install texture to match adjacent construction. Finish to match adjacent construction, unless otherwise indicated in Drawings.

END OF SECTION 083113

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SECTION 084600 WINDOW WALL ASSEMBLIES**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Frameless glazed interior wall and door assemblies.
- B. Framing and windows comprising exterior window wall assemblies.

1.02 RELATED REQUIREMENTS

- A. Section 088000 - Glazing.

1.03 REFERENCE STANDARDS

- A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- E. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- G. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- H. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's descriptive literature for each component in partition assembly.
- C. Shop Drawings: Indicate layout, dimensions, identification of components, and interface with adjacent construction.
 - 1. Include field measurements of openings.
 - 2. Include Elevations Showing:
 - a. Locations and identification of manufacturer-supplied door hardware and fittings.
 - b. Locations and sizes of cut-outs and drilled holes for other door hardware.

3. Include Details Showing:
 - a. Requirements for support and bracing of overhead track.
 - b. Installation details.
 - c. Appearance of manufacturer-supplied door hardware and fittings.
- D. Selection Samples: Two sets, representing manufacturer's full range of available materials and finishes.
- E. Verification Samples: Two samples, minimum size of 2 inch by 3 inch (51 mm by 76 mm), representing actual material and finish of elements exposed to view.
- F. Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, showing loads at points of attachment to the building structure.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than three years of documented experience.
 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until installation.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a one year period after Date of Substantial Completion.
- C. Manufacturer Warranty: Provide five-year manufacturer warranty against excessive degradation of metal finishes. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Frameless Glazed Interior Wall and Door Assemblies:
- B. Aluminum Framing, Windows, and Doors Comprising Exterior Window Wall Assemblies:
 1. Kawnner.
 2. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING FOR EXTERIOR WINDOW WALL ASSEMBLIES

- A. Assembly Components: Manufacturer's standard framing system, preglazed windows designed to be coupled together on site into multi-unit window wall assemblies.
 - 1. Aluminum Framing: Factory-fabricated, factory-finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - a. Glazing Position: Front-set.
 - b. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - c. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent stack effect in internal spaces.
 - d. System Internal Drainage: Drain to the exterior by means of a weep drainage network water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - e. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12-hour period without causing detrimental effect to system components, anchorages, and other building elements.
 - f. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 - g. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

2.03 FRAMELESS GLAZED INTERIOR WALL AND DOOR ASSEMBLIES

2.04 MATERIALS

- A. Primary Glass: Flat glass meeting requirements of ASTM C1036, Type I - Transparent Flat Glass, Class 2 - Tinted, Quality Q3, fully tempered in accordance with ASTM C1048, Kind FT, and as follows:
 - 1. Thickness: 1/4 inch (6.4 mm).
 - 2. Temper glass materials horizontally; visible tong marks or tong mark distortions are not permitted.
- B. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 3. Spacer Color: Black.
 - 4. Edge Seal:
 - a. Color: Black.
 - 5. Purge interpane space with dry air, hermetically sealed.
- C. Aluminum Components: Comply with ASTM B221 (ASTM B221M), alloy 6063, T5 temper.
- D. Sealant: One-part silicone sealant, comply with ASTM C920, clear.

2.05 FINISHES

- A. Aluminum Finishes:
 - 1. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.
- B. Fiberglass Finishes:

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as indicated on shop drawings.
- B. Verify floor flatness of 1/8 inch in 10 feet (3 mm in 3 m), non-cumulative.
- C. Do not begin installation until supports and adjacent substrates have been properly prepared.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean substrates thoroughly prior to installation.
- B. Prepare substrates using the methods recommended by the manufacturer for achieving acceptable result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with glazed interior wall and door assembly manufacturer's instructions.
- B. Fit and align glazed interior wall and door assembly level and plumb.
- C. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- D. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- E. Install sill, stool, apron, and _____.
- F. Set sill members and sill flashing in continuous bead of sealant.
- G. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

3.04 ADJUSTING

- A. Adjust glazed interior wall and door assembly to operate smoothly from sliding or pivoting positions.

3.05 CLEANING

- A. Remove protective film from exposed metal surfaces.

- B. Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents or other substances that may damage the material or finish.
- C. Glass and Glazing: Clean glazing surfaces; remove excess glazing sealant compounds, dirt, and other substances.

3.06 PROTECTION

- A. Protect installed products until Date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 084600

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SECTION 087100 DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for hollow metal doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Thresholds.
- E. Weatherstripping and gasketing.
- F. Gate locks.

1.02 RELATED REQUIREMENTS

- A. Section 080671 - Door Hardware Schedule: Schedule of door hardware sets.
- B. Section 081113 - Hollow Metal Doors and Frames.
- C. Section 281000 - Access Control: Electronic access control devices.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. BHMA A156.1 - Standard for Butts and Hinges; 2021.
- C. BHMA A156.2 - Bored and Preamsembled Locks and Latches; 2022.
- D. BHMA A156.4 - Door Closers and Pivots; 2024.
- E. BHMA A156.13 - Mortise Locks & Latches Series 1000; 2022.
- F. BHMA A156.16 - Standard for Auxiliary Hardware; 2023.
- G. BHMA A156.18 - Standard for Materials and Finishes; 2020.
- H. BHMA A156.21 - Thresholds; 2025.
- I. BHMA A156.22 - Standard for Gasketing; 2021.
- J. BHMA A156.25 - Electrified Locking Devices; 2023.
- K. BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems; 2023.
- L. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- M. DHI (KSN) - Keying Systems and Nomenclature; 2019.
- N. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 2004.
- O. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

- P. ITS (DIR) - Directory of Listed Products; Current Edition.
- Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- R. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- S. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- T. UL (DIR) - Online Certifications Directory; Current Edition.
- U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:
 - a. Contractor.
 - b. Owner.
 - c. Hardware Installer.
 - 3. Agenda:
 - a. Establish keying requirements.
 - b. Verify locksets and locking hardware are functionally correct for project requirements.
 - c. Verify that keying and programming complies with project requirements.
 - d. Establish keying submittal schedule and update requirements.
 - 4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
 - a. Access control requirements.
 - b. Key control system requirements.
 - 5. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
 - 6. Deliver established keying requirements to manufacturers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).

2. Provide complete description for each door listed.
 3. Provide manufacturer name, product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
- D. Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- G. Keying Schedule:
1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.
- H. Installer's qualification statement.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Warranty: Provide warranty against defects in material and workmanship for period indicated. Complete forms in Owner's name and register with manufacturer.
1. Closers: Five years, minimum.
 2. Locksets and Cylinders: Three years, minimum.
 3. Other Hardware: Two years, minimum.

PART 2 PRODUCTS**2.01 DESIGN AND PERFORMANCE CRITERIA**

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 4. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), testing firm acceptable to authorities having jurisdiction, or _____ as suitable for application indicated.
 - 5. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
 - 6. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- D. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
 - 1. See Section 281000 for additional access control system requirements.
- E. Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's series. See Door Hardware Schedule.
- F. Fasteners:
 - 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 - 2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
 - a. Self-drilling (Tek) type screws are not permitted.
 - 3. Fire-Rated Applications: Comply with NFPA 80.
 - a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
 - b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.

2.02 HINGES

- A. Hinges: Comply with BHMA A156.1, Grade 1.
 - 1. Provide hinges on every swinging door.
 - 2. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 - 3. Provide ball-bearing hinges at each door with closer.

4. Provide non-removable pins on exterior outswinging doors.
5. Provide power transfer hinges where electrified hardware is mounted in door leaf.
6. Provide following quantity of butt hinges for each door:
 - a. Doors From 60 inches (1.5 m) High up to 90 inches (2.3 m) High: Three hinges.

2.03 FLUSH BOLTS

- A. Manufacturers:
- B. Flush Bolts: Comply with BHMA A156.16, Grade 1.
 1. Flush Bolt Throw: 3/4 inch (19 mm), minimum.

2.04 LOCK CYLINDERS

- A. Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.
 1. Provide cylinders from same manufacturer as locking device.
 2. Provide cams and/or tailpieces as required for locking devices.

2.05 CYLINDRICAL LOCKS

- A. Cylindrical Locks (Bored): Comply with BHMA A156.2, Grade 1, 4000 Series.
 1. Bored Hole: 2-1/8 inch (54 mm) diameter.
 2. Latchbolt Throw: 1/2 inch (12.7 mm), minimum.
 3. Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
 4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.

2.06 MORTISE LOCKS

- A. Mortise Locks: Comply with BHMA A156.13, Grade 1, Security, 1000 Series.
 1. Latchbolt Throw: 3/4 inch (19 mm), minimum.
 2. Deadbolt Throw: 1 inch (25.4 mm), minimum.
 3. Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
 4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.

2.07 ELECTROMECHANICAL LOCKS

- A. Electromechanical Locks: Comply with BHMA A156.25, Grade 1, Security, 1000 Series.
 1. Provide motor-driven or solenoid-driven locks, with strike that is applicable to frame.
 2. Type: Mortise deadbolt.

2.08 CLOSERS

- A. Closers: Comply with BHMA A156.4, Grade 1.
 - 1. Type: Surface mounted to door.
 - 2. Provide door closer on each exterior door.

2.09 DOOR HOLDERS

- A. Door Holders: Comply with BHMA A156.16, Grade 1.
 - 1. Type: Lever, or kick down stop, with rubber bumper at bottom end.
 - 2. Material: Aluminum.

2.10 THRESHOLDS

- A. Manufacturers:
 - 1. Pemko; an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
- B. Thresholds: Comply with BHMA A156.21.
 - 1. Provide threshold at each exterior door, unless otherwise indicated.
 - 2. Type: Flat surface.
 - 3. Material: Aluminum.
 - 4. Threshold Surface: Fluted horizontal grooves across full width.
 - 5. Field cut threshold to profile of frame and width of door sill for tight fit.
 - 6. Provide non-corroding fasteners at exterior locations.

2.11 WEATHERSTRIPPING AND GASKETING

- A. Manufacturers:
 - 1. Pemko; an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
- B. Weatherstripping and Gasketing: Comply with BHMA A156.22.
 - 1. Head and Jamb Type: Adjustable.
 - 2. Door Sweep Type: Encased in retainer.
 - 3. Material: Aluminum, with brush weatherstripping.

2.12 COAT HOOKS

- A. Coat Hooks: Provide on room side of door, screw fastened.
- B. Material: Brass.

2.13 GATE LATCH

- A. Gate Latch: Provide to secure a gate used for traffic control to prevent pedestrian traffic into an area, located on inside of gate with turn piece.
 - 1. Material: Brass.

2.14 WIRELESS ACCESS MANAGEMENT SYSTEMS

- A. Wireless Access Management Systems: Comply with guidelines of BHMA A156.25, and including necessary hardware for fully functional system.
 - 1. Reader Formats: Provide magnetic stripe, proximity, dual validation, or key Fob to activate access system functionality.

2. Door Locking Hardware: Provide applicable cylindrical locksets, panic hardware, or mortise locksets in compliance with project access control requirements.

2.15 KEY CONTROL SYSTEMS

- A. Key Control Systems: Comply with guidelines of BHMA A156.28.
 1. Provide keying information in compliance with DHI (KSN) standards.
 2. Keying: Grand master keyed.
 3. Key to existing keying system.
 4. Supply keys in following quantities:
 - a. 1 each Grand Master keys.

2.16 FIRE DEPARTMENT LOCK BOX

- A. Manufacturers:
 1. Knox Company; Knox-Box Rapid Entry System, _____: www.knoxbox.com/#sle.
- B. Fire Department Lock Box:
 1. Capacity: Holds 10 keys.
 2. Finish: Manufacturer's standard dark bronze.

2.17 POWER SUPPLY

- A. Power Supply: Hard wired, with multiple zones providing eight (8) breakers for each output panel with individual control switches and LED's; UL (DIR) Class 2 listed.
 1. Power: 12 VAC, 20 Amp; with 120 VAC power supply.
 2. Operating Temperature: 32 to 110 degrees F (0 to 43 degrees C).
 3. Provide with emergency release terminals that release devices upon activation of fire alarm system.

2.18 FINISHES

- A. Finishes: Provide door hardware of same finish, unless otherwise indicated.
 1. Primary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 2. Secondary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 - a. Use secondary finish in kitchens, bathrooms, and other spaces containing chrome or stainless steel finished appliances, fittings, and equipment; provide primary finish on one side of door and secondary finish on other side if necessary.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C. Use templates provided by hardware item manufacturer.
- D. Do not install surface mounted items until application of finishes to substrate are fully completed.
- E. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 - 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 - 2. Mounting heights in compliance with ADA Standards:
 - a. Locksets: 40-5/16 inch (1024 mm).
 - b. Door Viewer: 43 inch (1092 mm); standard height 60 inch (1524 mm).
- F. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 014000 - Quality Requirements.
- B. Provide an Architectural Hardware Consultant (AHC) to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.04 ADJUSTING

- A. Adjust work under provisions of Section 017000 - Execution and Closeout Requirements.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

END OF SECTION 087100

SECTION 088000 GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealants for other than glazing purposes.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- C. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- E. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- F. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- G. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers; 2000 (Reapproved 2020).
- H. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- J. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres; 2020.
- K. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.
- L. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2023.
- M. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- N. GANA (GM) - GANA Glazing Manual; 2022.
- O. GANA (SM) - GANA Sealant Manual; 2008.

- P. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (Reaffirmed 2016).
- Q. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- R. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- S. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.
- T. NGA (LGRM) - Laminated Glazing Reference Manual; 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 12 by 12 _____ by _____ inch (_____ by _____ mm) in size of glass units.
- E. Samples: Submit 12 inch (_____ mm) long bead of glazing sealant, color as selected.
- F. Certificate: Certify that products of this section meet or exceed specified requirements.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with GANA (GM), GANA (SM), IGMA TM-3000, NGA (LGRM), and _____ for glazing installation methods. Maintain one copy on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.06 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F (4 degrees C).
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

- B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C. Laminated Glass: Provide a five (5) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
 - 2. Guardian Glass, LLC: www.guardianglass.com/#sle.
 - 3. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
 - 4. Or approved equals..

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality
- Q3.
- 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.

3. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality - Q3, with color and performance characteristics as indicated.
4. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

2.04 INSULATING GLASS UNITS

- A. Manufacturers:
 1. Glass: Any of the manufacturers specified for float glass.
- B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- C. Insulating Glass Units: Types as indicated.
 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Metal-Edge Spacers: Aluminum, bent and soldered corners.
 4. Spacer Color: Black.
 5. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 6. Purge interpane space with dry air, hermetically sealed.
 7. Pre-Equalized Insulated Glazing Units: Provide glazing units sealed at manufacturing plant with internal pressure matching pressure of the installation location.
- D. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: _____ Vitro Solarban 70 Optigray - Gray.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch (25.4 mm).
 6. Thermal Transmittance (U-Value), Winter - Center of Glass: 0.28, nominal.
 7. Visible Light Transmittance (VLT): 46 percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): 0.23, nominal.
 9. Visible Light Reflectance, Outside: 9 percent, nominal.

2.05 GLAZING COMPOUNDS**2.06 ACCESSORIES**

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) by width of glazing rabbet space minus 1/16 inch (1.5 mm) by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch (75 mm) long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.

PART 3 EXECUTION**3.01 VERIFICATION OF CONDITIONS**

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that the minimum required face and edge clearances are being provided.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- D. Verify that sealing between joints of glass framing members has been completed effectively.
- E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.

- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - STRUCTURAL SILICONE GLAZING

- A. Application - Factory (Shop) Glazed: Follow basic guidelines of structural silicone glazing for glazing application.
 - 1. Two-Sided Structural: Glass structurally adhered to vertical mullions with horizontal sides captured in glazing pockets.
- B. Provide design review of the glazing system and project details, adhesion testing, proper surface preparation, training and a quality service program.
- C. Provide only structural silicone sealant, tested and manufactured for structural glazing.

3.05 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.06 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 088000

SECTION 092116 GYPSUM BOARD ASSEMBLIES**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Metal stud wall framing.
- B. Gypsum sheathing.
- C. Gypsum wallboard.
- D. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing.
- B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 072100 - Thermal Insulation: Acoustic insulation.
- D. Section 072500 - Weather Barriers: Water-resistive barrier over sheathing.
- E. Section 072600 - Vapor Retarders: Vapor-impermeable membranes.
- F. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).
- B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.
- C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- G. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020 (Reapproved 2024).
- H. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

- I. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- J. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2024.
- K. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- L. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- M. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- N. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.
- O. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing; 2018 (Reapproved 2023).
- P. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.
- Q. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- R. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- S. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Samples: Submit two samples of gypsum board finished with proposed texture application, 12 by 12 inches (300 by 300 mm) in size, indicating finish color and texture.
- D. Steel Framing Industry Association (SFIA) Certification:
 - 1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion.

PART 2 PRODUCTS**2.01 GYPSUM BOARD ASSEMBLIES**

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.

2.02 METAL FRAMING MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
- C. Structural Steel Framing for Application of Gypsum Board: See Section 054000.
- D. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf (L/120 at 240 Pa).
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
- E. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
- F. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
 - 3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 - 4. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.
- G. Preformed Bottom of Wall Firestop Track Seal:
 - 1. Provide components UL-listed for use in UL-listed fire-resistance-rated bottom of partition joint systems indicated on drawings.
 - 2. Products:

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. Gold Bond Building Products, LLC provided by National Gypsum Company; ____: www.goldbondbuilding.com/#sle.
 2. PABCO Gypsum; ____: www.pabco gypsum.com/#sle.
 3. USG Corporation; ____: www.usg.com/#sle.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).
- C. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
1. Application: _____.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 4. Type: Regular and Type X, in locations indicated.
 5. Type X Thickness: 5/8 inch (16 mm).
 6. Regular Board Thickness: 5/8 inch (16 mm).
 7. Edges: Tapered.
- D. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Ceilings, unless otherwise indicated.
 2. Thickness: 1/2 inch (13 mm).
 3. Edges: Tapered.
- E. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. Application: Exterior sheathing, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Fungal Resistance: No fungal growth when tested in accordance with ASTM G21.
 4. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 5. Edges: Square.
 6. Glass Mat Faced Products:
 - a. Georgia-Pacific Gypsum; DensGlass Sheathing: www.gpgypsum.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
 - c. USG Corporation; Securock ExoAir 430 Panel USGX 5/8 in. (15.9 mm): www.usg.com/#sle.

2.04 GYPSUM BOARD ACCESSORIES

- A. Water-Resistive Barrier: See Section 072500.
- B. Vapor Retarder: See Section 072600.
- C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
- D. Beads, Joint Accessories, and Other Trim: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. L-Trim with Tear-Away Strip: Sized to fit 1/2-inch (13 mm) thick gypsum wallboard.
 - 3. Expansion Joints:
 - a. Type: V-shaped metal with factory-installed protective tape.
- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Paper Tape: 2 inch (50 mm) wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- F. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- G. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- H. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.
- I. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Studs: Space studs at 16 inches on center (at 406 mm on center).
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
- C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- D. Blocking: Install wood blocking for support of:
 1. Wall-mounted cabinets.
 2. Plumbing fixtures.
 3. Toilet accessories.
 4. Wall-mounted door hardware.

3.03 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- C. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- E. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
 1. Seal joints, cut edges, and holes with water-resistant sealant.
 2. Paper-Faced Sheathing: Immediately after installation, protect from weather by application of water-resistive barrier.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.05 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 2. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.06 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.07 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 092116

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SECTION 092216**NON-STRUCTURAL METAL FRAMING****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.

1.03 REFERENCE STANDARDS

- A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2024.
- D. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- E. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2024.
- F. ASTM C841 - Standard Specification for Installation of Interior Lathing and Furring; 2023.
- G. ASTM C844 - Standard Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster; 2015 (Reapproved 2021).
- H. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster; 2024.
- I. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- J. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.
- K. ASTM E413 - Classification for Rating Sound Insulation; 2022.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed steel studs and tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.06 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- B. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on Drawings.

2.02 FRAMING SYSTEMS

- A. Framing Members, General: Comply with AISI S220 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: Comply with ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.

- B. Studs and Track: ASTM C645.
 - 1. Minimum Base-Steel Thickness: As indicated on Drawings.
 - 2. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Steel Thickness: As indicated on Drawings.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Direct Furring:
 - 1. Screw to wood framing.

2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

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SECTION 092400 CEMENT PLASTERING**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Exterior vertical cement plasterwork (stucco).
- B. Related Requirements:
 - 1. Section 072500 "Weather Barriers" for water-resistive barrier adhered to sheathing.

1.03 REFERENCE STANDARDS

- A. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019 (Reapproved 2025).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM C847 - Standard Specification for Metal Lath; 2018 (Reapproved 2024).
- D. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster; 2024.
- E. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster; 2024.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples: For each type of factory-prepared finish coat and for each color and texture specified.

1.06 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup as part of integrated exterior mockup assembly per Section 014339 "Mockups."
 - 2. Build mockups for each substrate and finish texture indicated for cement plastering, including accessories.
 - a. Size: 100 sq. ft. (9 sq. m) in surface area.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.08 FIELD CONDITIONS

- A. Comply with ASTM C926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F (4.4 deg C).
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 PRODUCTS**2.01 CEMENT PLASTERING, GENERAL**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide LaHabra Fastwall 300 WaterMaster Krak-Shield Stucco Assembly, or equivalent system by one of the following manufacturers:
 - 1. Omega Products International, Inc.
 - 2. Sto Corporation
 - 3. Approved Equal

2.02 CEMENT PLASTER SYSTEM MATERIALS

- A. General: Comply with ASTM C926 for applications indicated.

- B. Scratch Coat and Brown Coat: Factory-mixed blend of portland cement, lime, sand, fibers and additives, mixed in the field with water. For use over metal lath.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide LaHabra Fiber-47 Fastwall Scratch & Brown Sanded, or approved equal.
 - 2. Thickness: 3/4 inch total thickness.
- C. Bonder and Admix: 100 percent acrylic admix emulsion for portland cement based products, to enhance curing, adhesion, freeze-thaw resistance and workability.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide LaHabra Acrylic Bonder & Admix, or approved equal.
- D. Leveling and Reinforcing Coat: Copolymer-binder-base leveler, bonds to stucco brown coat, with 4.5 oz. per sq. yd. reinforcing mesh.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Parex USA Stucco Level Coat and 355 Standard Mesh, or approved equal.
- E. Primer: 100 percent acrylic based coating, compatible with finish coat.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide LaHabra Perma-Primer, or approved equal.
- F. Finish: Factory-blended, 100 percent acrylic polymer-based finish, integrally colored.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide LaHabra Perma-Finish Acrylic finish, or approved equal.
 - 2. Color and texture as selected by Architect from manufacturer's full range.

2.03 METAL LATH

- A. Expanded-Metal Lath: ASTM C847, cold-rolled carbon-steel sheet with ASTM A653/A653M, G60 (Z180), hot-dip galvanized-zinc coating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CEMCO; California Expanded Metal Products Co.
 - b. ClarkDietrich Building Systems.
 - c. MarinoWARE.
 - d. Approved Equal
 - 2. Diamond-Mesh Lath: Self-furring, 2.5 lb/sq. yd.
- B. Paper Backing: FS UU-B-790a, Type I, Grade D, Style 2 vapor-permeable paper.

2.04 ACCESSORIES

- A. General: Comply with ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CEMCO; California Expanded Metal Products Co.
 - b. ClarkDietrich Building Systems.
 - c. MarinoWARE.
 - d. Approved Equal.
 - 2. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A653/A653M, G60 (Z180) zinc coating.

3. External- (Outside-) Corner Reinforcement: Fabricated from metal lath with ASTM A653/A653M, G60 (Z180), hot-dip galvanized-zinc coating.
4. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.
 - a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
 - b. Bullnose cornerbead, radius 3/4 inch (19 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
5. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
6. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
7. Expansion Joints: Fabricated from zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.

2.05 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.
- C. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster according to ASTM C926.

3.03 INSTALLING METAL LATH

- A. Metal Lath: Install according to ASTM C1063.

3.04 INSTALLING ACCESSORIES

- A. Install according to ASTM C1063 and at locations indicated on Drawings.
- B. Reinforcement for External (Outside) Corners:
 1. Install lath-type, external-corner reinforcement at exterior locations.
 2. Install cornerbead at interior locations.

- C. Control Joints: Locate as approved by Architect for visual effect and as follows:
1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft. (13.4 sq. m).
 - b. Horizontal and Other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
 2. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 4. Where control joints occur in surface of construction directly behind plaster.
 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.05 PLASTER APPLICATION

- A. General: Comply with ASTM C926.
1. Do not deviate more than plus or minus 1/4 inch in 10 feet (6 mm in 3 m) from a true plane in finished plaster surfaces when measured by a 10-foot (3-m) straightedge placed on surface.
 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
- B. Scratch Coat:
1. Apply scratch coat to a minimum thickness of 3/8 inch, using sufficient trowel pressure to key stucco into lath or to create bond to substrates as applicable.
 2. Prior to initial set, scratch horizontally to provide key for bond of brown coat.
 3. Moist cure scratch coat with clean potable water for at least 48 hours in accordance with ASTM C926 and the building codes following initial application.
- C. Brown Coat:
1. Apply brown coat to a minimum thickness of 3/8 inch, using sufficient trowel pressure to key stucco into scratch coat.
 2. Rod surface to true plane and float to densify.
 3. Trowel to smooth and uniform surface to receive acrylic polymer finish coat
 4. Moist cure brown coat with clean potable water for at least 48 hours, in accordance with ASTM C926 and the building codes.
- D. Leveling and Reinforcing Coat:
1. After Moist Curing, allow stucco base to air dry for 24 hours before applying the leveling and reinforcing coat.
 2. Using a stainless-steel trowel, apply the leveling coat over the stucco base at a thickness of 1/16 - 3/32 inch.
 3. Fully embed the reinforcing mesh, into the wet leveling coat including diagonal strips at corners of openings and trowel smooth. Overlap seams 2-1/2 inches.
 4. Apply acrylic primers and finishes as soon as the leveling coat has cured, typically after 24 hours.
- E. Primer and Finish:

1. Remove surface contaminants such as dust or dirt without damaging the substrate.
 2. Ambient and surface temperature must be 40 deg. F or higher during application and drying time. Supplemental heat and protection from precipitation must be provided as needed.
 3. Use only on surfaces that are sound, clean, dry, unpainted, and free from any residue that might affect the ability of the finish to bond to the surface.
 - a. Before the application of the finish, the base coat must have cured a minimum of 24 hours or longer as required by weather conditions. Examine the cured base coat for any irregularities.
 - b. Correct these irregularities to produce a flat surface.
 4. Apply exterior wall finish coats according to product data sheets.
 5. Protect Finish Coats from inclement weather until completely dry.
- F. Curing: Air cure acrylic based and elastomeric finish coats only, do not wet cure.

3.06 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of other work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

SECTION 096500 RESILIENT FLOORING**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

1.02 REFERENCE STANDARDS

- A. ASTM D6329 - Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers; 1998 (Reapproved 2023).
- B. ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine; 2025.
- C. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025.
- D. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- E. ASTM F1700 - Standard Specification for Solid Vinyl Floor in Modular Format such as Tile(s) or Plank(s); 2025.
- F. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021 (Reapproved 2025).
- G. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
- H. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- I. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.

1.05 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

PART 2 PRODUCTS**2.01 TILE FLOORING**

- A. Vinyl Tile: Printed film type, with transparent or translucent wear layer; acoustic interlayer or backing.
 - 1. Manufacturers:
 - a. Armstrong Flooring; Unify: www.armstrongflooring.com/#sle.
 - 2. Minimum Requirements: Comply with ASTM F1700, Class III.
 - 3. Impact Insulation Class (IIC): 57, minimum, when floor-ceiling assembly tested in accordance with ASTM E492.
 - 4. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648.
 - 5. Mold and Microbial Resistance: Highly resistant when tested in accordance with ASTM D6329.
 - 6. Plank Tile Size: 8 by 40 inch (203 by 1016 mm).
 - 7. Wear Layer Thickness: 0.020 inch (0.50 mm).
 - 8. Total Thickness: 0.20 inch (5 mm).
 - 9. Tile Edge: Interlocking shape.
 - 10. Color: As indicated on drawings.

2.02 RESILIENT BASE

- A. Resilient Base - Type _____: ASTM F1861, Type TP, rubber, thermoplastic; style as scheduled.
 - 1. Manufacturers:
 - a. Flexco Corporation; _____: www.flexcofloors.com/#sle.
 - b. Mannington Commercial; _____: www.manningtoncommercial.com/#sle.
 - c. Roppe Corporation; Contours Profiled Wall Base System: www.roppe.com/#sle.
 - d. Tarkett Flooring: www.tarkett.com/#sle.
 - e. Or equal.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. Height: 4 inches (100 mm).
 - 4. Thickness: 0.125 inch (3.2 mm).
 - 5. Finish: Satin.

6. Length: Roll.
7. Color: To be selected by Architect from manufacturer's full range.

2.03 ACCESSORIES

- A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- B. Adhesive for Vinyl Flooring:
- C. Moldings, Transition and Edge Strips: Same material as flooring.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.
 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.
- E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed. Apply primer to _____ surfaces.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 1. Spread only enough adhesive to permit installation of materials before initial set.
 2. Fit joints and butt seams tightly.

3. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.
- C. Install plank tile with a random offset of at least 6 inches (152 mm) from adjacent rows.

3.05 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.
- B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 096500

SECTION 099123 INTERIOR PAINTING**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Primers.
 - 2. Water-based finish coatings.
 - 3. Floor sealers and paints.

1.03 REFERENCE STANDARDS

- A. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).
- B. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Products are indicated in FINISH LEGEND on Drawings in this format:
 - a. PT-# Where # is a sequential number.
 - b. Manufacturer, Color, Sheen and related requirements are indicated.
 - c. Submit product data for each type indicated.
 - 2. Include preparation requirements and application instructions.
 - 3. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.05 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. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.06 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.08 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Basis-of-design: as indicated on Drawings.
- B. Or Approved Equal.
- C. Source Limitations: Obtain each paint product from single source from single manufacturer

2.02 PAINT PRODUCTS, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

- B. Colors: as indicated on Drawings..

2.03 PRIMERS

- A. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.

2.04 WATER-BASED FINISH COATS

- A. Interior, Latex,: Pigmented, water-based paint for use on primed/sealed interior plaster and gypsum board, and on primed wood and metals.
 - 1. Basis-of-design: as indicated on FINISH LEGEND in Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Fiber-Cement Board: 12 percent.
 - 3. Masonry (Clay and CMUs): 12 percent.
 - 4. Wood: 15 percent.
 - 5. Gypsum Board: 12 percent.
 - 6. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 1. SSPC-SP 2.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 2. Sand surfaces that will be exposed to view, and dust off.
 3. Prime edges, ends, faces, undersides, and backsides of wood.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.03 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
 - 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 099123

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SECTION 101400 SIGNAGE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Interior and exterior accessibility, room-identification, directional, and informational signs that are directly attached to the building.
 - 2. Miscellaneous signage as detailed on Drawings.

1.03 REFERENCE STANDARDS

- A. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet; 2016.

1.04 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.05 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. Use materials and products of one manufacturer whenever possible.
- C. All materials, components, assemblies workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- D. The adhesion of inlaid letters and symbols will be tested.
- E. All signage shall be field inspected after installation in accordance with CBC 11B-703.1.1.2.

1.06 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

1.07 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.08 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Sample Warranty: For special warranty.

1.09 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in CBC Chapter 11B-703 Signs.

2.02 SIGNAGE

- A. Interior Signage: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: 0.125 inch (3.18 mm).
 - b. Subsurface Graphics: Reverse etch image.
 - c. Color(s): As selected by Architect from manufacturer's full range.
 - 2. Sign-Panel Perimeter: Finish edges smooth.

- a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: As indicated on Drawings.
3. Mounting: Surface mounted to wall with two-face tape.
4. Text and Typeface: Accessible raised characters and Braille, typeface as selected by Architect from manufacturer's full range. Finish raised characters to contrast with background color, and finish Braille to match background color.
5. Raised Characters: Raised characters shall comply with Section 11B-703.2 as follows and shall be duplicated in Braille complying with Section 11B-703.3. Raised characters shall be installed at heights and locations in accordance with Section 11B-703.4.
 - a. Depth: Raised characters shall be 1/32-inch minimum above their background.
 - b. Case: Characters shall be uppercase.
 - c. Style: Characters shall be sans serif. Characters shall not be italic, oblique, script, highly decorative, or of other unusual forms.
 - d. Character proportions: Characters shall be selected from fonts where the width of the uppercase letter "O" is 60 percent minimum and 110 percent maximum of the height of the uppercase letter "I".
 - e. Character height: Character height measured vertically from the baseline of the character shall be 5/8-inch minimum and 2-inches maximum based on the height of the uppercase letter "I".
 - f. Stroke thickness: Stroke thickness of the uppercase letter "I" shall be 15 percent maximum of the height of the character.
 - g. Character spacing: Character spacing shall be measured between the two closest points of adjacent raised characters within a message, excluding word spaces. Where characters have rectangular cross sections, spacing between individual raised characters shall be 1/8-inch minimum and 4-times the raised character stroke width maximum. Where characters have other cross sections, spacing between individual raised characters shall be 1/16-inch minimum and 4-times the raised character stroke width maximum at the top of the cross sections. Characters shall be separated from raised borders and decorative elements 3/8-inch minimum.
 - h. Line spacing: Spacing between the baselines of separate lines of raised characters within a message shall be 135-percent minimum and 170-percent maximum of the raised character height.
 - i. Format: Text shall be in a horizontal format
6. Braille: Braille shall be contracted (Grade 2) and shall comply with Sections 11B-703.3 as follows and 11B-703.4 for installation height and location.
 - a. Dimensions and capitalization: Braille dots shall have a domed or rounded shape and shall comply with Table 11B-703.3.1 and as shown on drawings. The indication of an uppercase letter or letters shall only be used before the first word of sentences, proper nouns and names, individual letters of alphabet, initials, and acronyms.

b. Position: Braille shall be positioned below the corresponding text in a horizontal format, flush left or centered. If text is multi-lined, Braille shall be placed below the entire text. Braille shall be separated 3/8-inch minimum and 1/2-inch maximum from any other tactile characters and 3/8-inch minimum from raised borders and decorative elements.

7. Visual Characters: Visual characters shall comply with Section 11B-703.5 as follows.

- a. Exception: Where visual characters comply with Section 11B-703.2 requirements for raised characters and are accompanied by Braille complying with Section 11B-703.3, they shall not be required to comply with Sections 11B-703.5.2 through 11B-703.5.6 for case, style, character proportions, character height, and mounting height; 11B-703.5.8 for character spacing; and 11B-703.5.9 for line spacing.
 - b. Finish and contrast: Characters and their background shall have a non-glare finish. Characters shall contrast with their background with either light characters on a dark background or dark characters on a light background.
 - c. Case: Characters shall be uppercase or lowercase or a combination of both.
 - d. Style: Characters shall be conventional in form. Characters shall not be italic, oblique, script, highly decorative, or of other unusual forms.
 - e. Character proportions: Characters shall be selected from fonts where the width of the uppercase letter "O" is 60 percent minimum and 110 percent maximum of the height of the uppercase letter "I".
 - f. Character height: Minimum character height shall comply with Table 11B-703.5.5. Viewing distance shall be measured as the horizontal distance between the character and an obstruction preventing further approach towards the sign. Character height shall be based on the uppercase letter "I".
 - g. Height from finish floor or ground: Visual characters shall be 40-inches minimum above the finish floor or ground.
 - h. Stroke thickness: Stroke thickness of the uppercase letter "I" shall be 10-percent minimum and 20-percent maximum of the height of the character.
 - i. Character spacing: Character spacing shall be measured between the two closest points of adjacent characters, excluding word spaces. Spacing between individual characters shall be 10-percent minimum and 35-percent maximum of character height.
 - j. Line spacing: Spacing between the baselines of separate lines of characters within a message shall be 135-percent minimum and 170-percent maximum of the character height.
 - k. Format: Text shall be in a horizontal format.
8. Pictograms: Pictograms shall comply with Section 11B-703.6 as follows.
- a. Pictograms field: Pictograms shall have a field height of 6-inches minimum. Characters and Braille shall not be located in the pictogram field.
 - b. Finish and contrast: Pictograms and their field shall have a non-glare finish. Pictograms shall contrast with their field with either a light pictogram on a dark field or a dark pictogram on a light field.
 - c. Text descriptors: Pictograms shall have text descriptors located directly below the pictogram field. Text descriptors shall comply with Sections 11B-703.2 (raised characters), 11B-703.3 (Braille) and 11B-703.4 (height and location).

9. Symbols of Accessibility: Symbols of accessibility shall comply with Section 11B-703.7 as follows.

- a. Finish and contrast: Symbols of accessibility and their background shall have a non-glare finish. Symbols of accessibility shall contrast with their background with either a light symbol on a dark background or a dark symbol on a light background.
- b. International Symbol of Accessibility: The International Symbol of Accessibility shall comply with Figure 11B-703.7.2.1 and as shown on drawings. The symbol shall consist of a white figure on a blue background, or as otherwise approved by the Authority Having Jurisdiction. The blue shall be Color No. 15090 in Federal Standard 595B.

2.03 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
 1. Additional materials as shown in Details on Drawings.
- B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.04 ACCESSORIES

- A. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

2.05 FABRICATION

- A. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- B. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

2.06 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical 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.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.
- C. Mounting Methods:
1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.02 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101400

SECTION 102800**TOILET, BATH, AND LAUNDRY ACCESSORIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- C. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2024.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- E. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.
- G. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- I. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Commercial Toilet, Shower, and Bath Accessories:

1. American Specialties, Inc; _____: www.americanspecialties.com/#sle.
 2. Bradley Corporation; _____: www.bradleycorp.com/#sle.
 3. Georgia-Pacific Professional; _____: www.gppro.com/#sle.
- B. Under-Lavatory Pipe Supply Covers:
1. Plumberex Specialty Products, Inc; : www.plumberex.com/#sle.
- C. Provide products of each category type by single manufacturer.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
1. Grind welded joints smooth.
 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B. Stainless Steel Sheet: ASTM A666/A666M, Type 304.
- C. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- D. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- E. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
- F. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Combination Toilet Paper/Seat Cover Dispenser with Napkin Disposal: Double roll; Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges.
- B. Paper Towel Dispenser: Folded paper type, thermoplastic polymer, surface-mounted, with viewing slots on sides as refill indicator and tumbler lock.
1. Capacity: 500 multifold minimum.
- C. Waste Receptacle: Stainless steel, freestanding style.
1. Liner: Removable rigid molded plastic receptacle.
 2. Minimum capacity: 10 gallons (38 liters).
- D. Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and horizontal stainless steel tank and working parts; push type soap valve, check valve, and window gauge refill indicator, tumbler lock.
- E. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.
1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 2. Size: _____.

3. Frame: 0.05 inch (1.3 mm) angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
 4. Backing: Full-mirror sized, minimum 0.03 inch (0.8 mm) galvanized steel sheet and nonabsorptive filler material.
- F. Grab Bars: Stainless steel, smooth surface.
1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/2 inch (38 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.

2.05 UNDER-LAVATORY PIPE AND SUPPLY COVERS

- A. Under-Lavatory Pipe and Supply Covers:
1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
 2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
 3. Construction: 1/8 inch (3.2 mm) flexible PVC.
 - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - b. Comply with ASTM C1822, type indicated.
 - c. Comply with ASME A112.18.9.
 - d. Comply with ICC A117.1.
 4. Color: White.
 5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
 6. Products:
 - a. Plumberex Specialty Products, Inc; Plumberex Handy-Shield Maxx: www.plumberex.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
- D. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 102800

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SECTION 104416 FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.
- B. Related Requirements:
 - 1. Section 104413 "Fire Protection Cabinets."

1.03 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.07 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
2. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated. Where not otherwise indicated provide manufacturer's standard wall mounting bracket.
- B. Manufacturers: JL Industries, LAresen's, Amerex or equal.
 1. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
- C. Extinguisher types are indicated on Drawings, coordinate with requirements including those on Code Compliance and Exiting Plans.
- D. Minimum Extinguisher Ratings:
 1. Multi-Purpose (MP): Dry Chemical 10 lb. capacity, 4A:80B:C rating.
 2. Carbon Dioxide (CD): 10 lb. capacity, 10B:C rating.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

1. Mounting Height: Top of fire extinguisher to be at above finished floor.

END OF SECTION 104416

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SECTION 220050**BASIC PLUMBING MATERIALS AND METHODS****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Valve boxes.
 - 2. Access Doors.
 - 3. Insulation.

1.02 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.

1.03 ADDITIONAL REQUIREMENTS

- A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.

1.04 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, 2022.
 - b. California Electrical Code, 2022.
 - c. California Energy Code, 2022.
 - d. California Fire Code, 2022.

- e. California Green Building Standards Code, 2022.
 - f. California Mechanical Code, 2022.
 - g. California Plumbing Code, 2022.
 - 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.

1.05 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.

1.06 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. 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.

1.07 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.

1.08 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.
- C. Sustainable Design Submittals:
 - 1. Product Data: For adhesives and sealants, documentation of compliance including printed statement of VOC content and chemical components.]
 - 2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.]
- 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 116875. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 116875.
- 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 HCAI 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 2022 California Building Code
 - 4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.09 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/warranties 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) A complete list or schedule of all 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.
 - 12) Check test and start reports for each piece of plumbing equipment provided as part of the Work.
 - 13) 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 116875.

- 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, and duration and effective date of Contractor's Standard Guarantee.
- 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 warranty requirements 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

2.01 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.

2.02 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).

2.03 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.

2.04 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.

2.05 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.

2.06 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.07 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.

2.08 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 domestic cold water piping located within building, outside of insulation envelope in outside walls, vented attic spaces, and unheated spaces, including

equipment rooms and below raised floor with 1 inch thick molded fiberglass, minimum 3-1/2 pound per cubic foot density, with ASJ-SSL jacket.

3. Insulate domestic cold water piping located outside building exposed to weather with minimum 3-1/2 pounds per cubic foot density fiberglass with ASJ-SSL jacket. Insulation thickness for all pipe sizes: 2 inches.
4. 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.

PART 3 EXECUTION

3.01 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.

3.02 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 IIR 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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. 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 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.

F. 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.

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. 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</u>	<u>Steel Gas</u>	<u>Copper</u>	<u>CPVC & PVC (Note 2)</u>
	<u>Threaded or Welded (Note 3)</u>		<u>Brazed or Soldered (Note 3)</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</u> <u>Diameter</u>	<u>Steel</u> <u>Threaded or</u> <u>Welded</u> (Note 2)	<u>Steel Gas</u>	<u>Copper</u> <u>Brazed or</u> <u>Soldered</u> (Notes 2, 3)	<u>CPVC & PVC</u> (Note 1)
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. 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.
- c. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.

- d. 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.
 - e. 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.
 - f. 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.

3.08 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 116875.
- 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 116875.
- C. Locate the unions for easy removal of the equipment, tank, or valve.

3.09 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. 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. test machine (San Gabriel, CA - 818-287-5259), Pipeline Inspection Company (Houston, TX - 713-681-5837), 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. 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.

- F. 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.
- G. 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.
- H. 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. Apply markings after painting and cleaning of piping and insulation is completed.

3.13 EXPANSION ANCHORS IN HARDENED CONCRETE

- A. Refer to Structural Drawings.
- B. Qualification Tests: The specific anchor shall have a current ICC-ES report and evaluated in cracked concrete in accordance with Acceptance Criteria AC193. If the specific anchor satisfies cyclic testing requirements per Acceptance Criteria AC01, Section 5.6, the full allowable shear and tension loads listed in the current ICC-ES report and manufacturer's recommendations for the specific anchor may be used. Otherwise, the design shear and tension loads shall not be more than 80% of the listed allowable shear and tension loads for the specific anchor.
- C. Installation: The anchors must be installed in accordance with the requirements given in ICC Research Committee Recommendations for the specific anchor.
- D. Testing: Fifty percent of the anchors shall be load-tested on each job to twice the allowable capacity in tension, except that if the design load is less than 75 pounds; only one anchor in ten need be tested. If any anchor fails, all anchors must be tested. The load test shall be performed in the presence of a special inspector.

- E. The load may be applied by any method that will effectively measure the tension in the anchor, such as direct pull with a hydraulic jack, a torque wrench calibrated using the specific anchor or calibrated spring-loading devices. Anchors in which the torque is used to expand the anchor without applying tension to the bolt may not be verified with a torque wrench.

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 22 00 50

SECTION 221000 PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Valves.
 - 3. Domestic water piping specialties.
 - 4. Drain and waste piping specialties.

1.02 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.

1.03 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.

1.04 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Gas Pipe Installer Qualifications: Provide evidence of current qualifications for individuals performing work requiring qualifications.

1.05 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.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

1.07 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

PART 2 - PRODUCTS**2.01 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."

2.02 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. 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. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe above grade.
 2. 2-1/2 inch and smaller: Cast iron soil pipe and fittings as specified for sizes 3 inch and larger, 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. 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.
- F. 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.
- G. 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 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.
 5. Provide cleanout tees or "Y" at each change in direction.

2.03 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. 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.
- C. Water Service Piping Above Grade.
1. Sizes 3 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 2-1/2 inches and smaller: Type K copper tubing, hard temper, with brazed wrought copper fittings.

2.04 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 other 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.

2.05 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 116875.
 - 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 116875.
- B. 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.
- C. Calibrated Balancing Valves:
 - 1. General: Calibrated orifice ball type rated for 400 psig maximum operating pressure and 250 degrees F. maximum operating temperature.
 - 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. 3 Inch and Smaller: Bell & Gossett model CB, "LF" series.

2.06 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 116875, 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 116875, 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 116875.
 - 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. 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 116875. 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.
- G. 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.
- H. 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.
- I. 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.

2.07 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 ½ 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.
6. Cleanouts exterior to building in landscaped areas: Zurn Z-1449-BP, or equal, cleanout ferrule with tapered bronze plug. Where located at grade, provide 18 by 18 by 6 inch concrete pad; Trowel concrete smooth and edge; set flush with finished grade.
7. Cleanouts in drive areas: Zurn -1400-HD-KC, or equal, with heavy-duty top and ABS plastic plug.

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. 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.

PART 3 - EXECUTION

3.01 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.

3.02 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.]

3.03 INSTALLATION OF SANITARY AND STORM DRAINAGE SYSTEMS

- A. Make joints in PVC sewer pipe with PVC-type couplings and rubber rings.
- B. Check final location of rubber rings within the couplings with gauge or as recommended by the manufacturer. Make joints between PVC pipe and cast iron pipe or fittings using cast iron adapter fittings, installed as recommended by the manufacturer.
1. Ring-Tite cast iron pipe fittings may be used in lieu of standard fittings. Make connection to valves with cast iron adapters connected to the pipe with PVC couplings.
- C. 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.
- D. 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.
- E. 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.
- F. Grade all vent piping so as to free itself quickly of any water condensation.
- G. 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.
- H. Hubless Cast Iron Joints: Comply with coupling manufacturer's installation instructions.

3.04 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. 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.
- E. 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.
- 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, 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.

3.05 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. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.
- D. 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.

3.06 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.

3.07 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.

3.08 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.

3.09 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.
- F. Operator workroom shall include provisions for a coffee maker water supply. 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.

3.10 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.

3.11 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.

3.12 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.13 TESTING AND BALANCING

- A. See Section 23 05 93 of Specifications for testing and balancing requirements.

3.14 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 22 10 00

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SECTION 224000 PLUMBING FIXTURES**PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Water supplies and stops.
 - 2. Plumbing fixture hangers and supports.
 - 3. Refrigerator ice maker outlet boxes.

1.02 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.

1.03 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.05 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.

1.06 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. Americans with Disabilities Act (ADA).

PART 2 - PRODUCTS

2.01 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.

2.02 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.

2.03 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.

2.04 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. Plumbing Trim:
 - a. McGuire Manufacturing Co., Inc.
 - b. Delta Commercial.
 - c. Chicago Faucet Co.
 - d. T&S Brass and Bronze Works, Inc.
 - 3. Flush Valves:
 - a. Sloan Valve Co.
 - b. Zurn Industries, Hydromechanics Div.
 - c. Toto USA, Inc.
 - 4. Faucets:
 - a. Chicago Faucet Co.
 - b. Symmons Scott.
 - c. T&S Brass and Bronze Works, Inc.
 - d. Delta Commercial.
 - 5. Fixture Seats:
 - a. Church Seat Co.
 - b. Bemis Mfg. Co.
 - c. Beneke Corp.
 - 6. Stainless Steel Sinks:
 - a. Elkay Mfg. Co.
 - b. Just Mfg. Co.

- c. Haws Corporation.
- 7. Fixture Carriers:
 - a. Josam Mfg. Co.
 - b. J. R. Smith.
 - c. Tyler Pipe; Wade Div.
 - d. Zurn Industries; Hydromechanics Div.
 - e. Mifab, Inc.

2.05 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.

2.06 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. 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.

2.07 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 116875, 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.

2.08 PLUMBING FIXTURE HANGERS AND SUPPORTS

- A. Floor-affixed supports for off-the-floor plumbing fixtures shall comply with ASME A112.6.1M.
- B. Residential type fixture supports are not acceptable.
- C. Install wall mounted water closets with combination support and waste fittings, with feet of support securely anchored to floor.
- D. 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.
- E. 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.

2.09 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.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.]

3.04 FAUCET INSTALLATION

- A. Provide 85 percent IPS red brass pipe, conforming to lead-free requirements of California Health and Safety Code Section 116875, 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.

3.05 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.

3.06 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.

3.07 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 22 40 00

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SECTION 225000 PLUMBING EQUIPMENT**PART 1 - GENERAL****1.01 SUMMARY****A. SECTION INCLUDES**

1. Instantaneous electric water heaters.

1.02 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.

1.03 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.

1.04 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.05 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.

1.06 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. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.
- G. California Energy Commission Compliance: Provide written confirmation of listing of all water heaters in the "Appliance Efficiency Database."

1.07 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

2.01 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).

2.02 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. General: Wall mounted, microprocessor-controlled, electric heating style.
- B. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
- C. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - 1. Connections: ASME B1.20.1 pipe thread.
 - 2. Pressure Rating: 150 psig .
 - 3. Heating Element: Resistance heating system.
 - 4. Temperature Control: Flow-control fitting.
 - 5. Safety Control: High-temperature-limit cutoff device or system
 - 6. Jacket: Aluminum or steel with enameled finish or plastic.
- D. Support: Bracket for wall mounting.
- E. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Chronomite Laboratories, Inc.
 - 2. Eemax, Inc.

PART 3 - EXECUTION**3.01 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.

3.02 ELECTRIC WATER HEATER INSTALLATION

- A. Install electric 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 valve, check valve, and dielectric union in the cold water line, and ASME standard pressure and temperature relief valve and dielectric union in the hot water line. Connect drain and relief piping as noted on Drawings.
- D. Start-up, test, and adjust electric water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.
- E. After installation has been completed, seal bottom of heaters without feet to floor with silicone sealer.

3.03 DEMONSTRATION AND TRAINING

- A. Provide a minimum of 4 hours of training and orientation of Owners staff in proper care and operation of Plumbing Equipment.

3.04 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.

3.05 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.06 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 22 50 00

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SECTION 230050**BASIC HVAC MATERIALS AND METHODS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Electric motors.
 - 2. Access Doors.

1.02 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.

1.03 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.

1.04 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, 2022.
 - b. California Electrical Code, 2022.
 - c. California Energy Code, 2022.
 - d. California Fire Code, 2022.
 - e. California Green Building Standards Code, 2022.
 - f. California Mechanical Code, 2022.
 - g. California Plumbing Code, 2022.
 - 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.

1.05 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 Contractors' 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.

1.06 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.

1.07 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.

1.08 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.
- C. Sustainable Design Submittals:
 - 1. Product Data: For adhesives and sealants, documentation of compliance including printed statement of VOC content and chemical components.
 - 2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
- 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 HCAI 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 2022 California Building Code

4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.09 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. 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, and duration and effective date of Contractor's Standard Guarantee.
- 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

2.01 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.

2.02 MATERIALS

- A. No material installed as part of this Work shall contain asbestos.
- B. California Green Building Code Compliance:
1. HVAC and refrigeration equipment shall not contain CFCs.
 2. HVAC and refrigeration equipment shall not contain Halons.

2.03 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 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.

2.04 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.

2.05 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.

2.06 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.07 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.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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 3 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.

3.08 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.

3.09 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.

3.10 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.

3.11 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.

3.12 EXPANSION ANCHORS IN HARDENED CONCRETE

- A. Qualification Tests: The specific anchor shall have a current ICC-ES report and evaluated in cracked concrete in accordance with Acceptance Criteria AC193. If the specific anchor satisfies cyclic testing requirements per Acceptance Criteria AC01, Section 5.6, the full allowable shear and tension loads listed in the current ICC-ES report and manufacturer's recommendations for the specific anchor may be used. Otherwise, the design shear and tension loads shall not be more than 80% of the listed allowable shear and tension loads for the specific anchor.
- B. Installation: The anchors must be installed in accordance with the requirements given in ICC Research Committee Recommendations for the specific anchor.
- C. Testing: Fifty percent of the anchors shall be load-tested on each job to twice the allowable capacity in tension, except that if the design load is less than 75 pounds; only one anchor in ten need be tested. If any anchor fails, all anchors must be tested. The load test shall be performed in the presence of a special inspector.
- D. The load may be applied by any method that will effectively measure the tension in the anchor, such as direct pull with a hydraulic jack, a torque wrench calibrated using the specific anchor or calibrated spring-loading devices. Anchors in which the torque is used to expand the anchor without applying tension to the bolt may not be verified with a torque wrench.

3.13 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.

3.14 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.

3.15 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.

3.16 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.

3.17 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.

3.18 ACCEPTANCE REQUIREMENTS

- A. Contractor shall complete the applicable Acceptance Requirements for Code Compliance contained in the California Building Energy Efficiency Standards. Refer to T-24 compliance forms on Drawings for systems having Acceptance testing requirements. Contractor shall perform Acceptance tests and complete the appropriate "Certificates of Acceptance." Submit certificates to the authorities having jurisdiction for approval and issuance of final occupancy permit. Contractor shall engage certified HERS Rater to verify duct leakage rate for duct systems indicated on T-24 compliance forms on Drawings as requiring duct leakage rate testing. For additional duct leak testing requirements, refer to Section 238000, "Heating, Ventilating, and Air Conditioning," Article, "Ductwork Sealing and Leak Testing."

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 23 00 50

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SECTION 230593**TESTING, ADJUSTING, AND BALANCING FOR HVAC PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.02 RELATED REQUIREMENTS

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

1.03 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.

1.04 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:

Similar Terms		
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.

1.05 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. LEED Submittals:
 - 1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - 2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 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.

1.07 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.

1.08 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. TAB Conference: Meet with Architect and mechanical engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the project requirements. Require the participation of the TAB field supervisor. Provide seven days' advance notice of scheduled meeting time and location. TAB conference shall take place at location selected by Architect offices of Capital.
 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow, including protocol for resolution tracking and documentation.
 2. The requirement for TAB conference may be waived at the discretion of the mechanical engineer of record for the Project.
- I. 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.
- J. TAB Report Forms: Use standard TAB specialist's forms approved by Architect.
- K. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- L. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- M. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.09 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

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 seven 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

3.01 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 operating safety interlocks and controls on HVAC equipment.
- J. Report conditions requiring correction discovered before and during performance of TAB procedures.
- K. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 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. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 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.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- 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 238000 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.

3.04 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. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- F. 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.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling-unit components.
- M. Verify that air duct system is sealed as specified in Section 238000 "Heating, Ventilating, and Air Conditioning."
- N. 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.
- O. Automatically operated dampers shall be adjusted to operate as indicated in Contract Documents. Controls shall be checked for proper calibration.

3.05 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.

3.06 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.07 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."
- B. Set plumbing systems water flow rates within plus or minus 10 percent.

3.08 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.

3.09 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. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. 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. Duct, outlet, and inlet sizes.
 3. Pipe and valve sizes and locations.
 4. Terminal units.

5. Balancing stations.
 6. 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. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
- I. 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.
- J. 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.

K. 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.

L. Instrument Calibration Reports:

- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.10 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.

3.11 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 230593

SECTION 238000**HEATING, VENTILATING AND AIR CONDITIONING PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Split system heat pump units.
 - 2. Split system air conditioning units.
 - 3. Refrigerant piping and fittings.
 - 4. Fans.
 - 5. Air inlets and outlets.
 - 6. Filters.
 - 7. Dampers.
 - 8. Ductwork.
 - 9. Insulation.
 - 10. Thermal hanger shield inserts.

1.02 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.

1.03 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.
- 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.

1.04 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.

- B. Record of pre-installation meeting.
- C. Coordinated Layouts: Submit coordinated layouts. For requirements refer to article, Coordinated Layouts, in this Section.

1.05 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.

1.06 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. Provide one complete set(s) of filters for each filter bank.

1.07 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:

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.

1.08 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.

PART 2 - PRODUCTS

2.01 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).

2.02 SPLIT SYSTEM HEAT PUMPS

- A. General: Furnish and install split system air-to-air heat pump system, 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. Heating/Cooling System: The total certified heating/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.
 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 heat/auto/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 manufacturers washable filters 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.

2.03 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.
 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.

2.04 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.
- 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.

2.05 REFRIGERANT ACCESS VALVE LOCKING CAPS

- A. Each refrigerant circuit access valve located outside buildings, including valves located on roofs, shall be provided with a locking cap. Caps shall be of metal construction, with threaded brass inserts. Caps shall be color-coded according to ASHRAE standards. Caps shall be removable only with cap manufacturer's handheld tool.
 - 1. Provide minimum of two (2) cap removal tools for every ten (10) air conditioning units or other systems containing refrigerant installed under this Project.

2.06 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. 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.
- E. Motors:
 - 1. 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.
- F. 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.
- G. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.07 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.

2.08 AIR FILTERS

- A. Provide MERV 13 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.

2.09 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 damper. 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. 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.)
 - b. 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 power. 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.
 - c. 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.

- d. 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.
- e. 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.
- f. 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.
- g. 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.

2.10 DUCTWORK

- A. Construct and install 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.
 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.
- B. 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.
- C. Duct sizes indicated are external sizes.

- D. 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.
- E. 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.
- F. Duct Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, straps, trim, and angles for support of ductwork.
- G. 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.
- H. 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

I. 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 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>
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.
- J. 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.
- K. 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 5 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.
 5. Duct Access Panels:
 - a. Provide duct access panel assembly of the same material and gauge used for the duct. Duct access panels shall conform to the following:
 - 1) Fasteners: Black steel or stainless steel to match material used for the duct. Panel fasteners shall not penetrate duct wall.
 - 2) Gasket: Comply with NFPA 96, grease-tight, high temperature ceramic fiber, rated for minimum 1500 °F.
- L. Flexible Connectors:
1. Materials: Flame-retardant or noncombustible fabrics. Coatings and adhesives shall comply with UL 181, Class 1, with flame spread index of 25 or less, and smoke-developed index of 50 or less.

2. Metal-Edged Connectors: Factory fabricated with a fabric strip 3 inches wide attached to two strips of 3-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
3. Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Tensile Strength: Minimum 475 lbf/inch in the warp and minimum 375 lbf/inch in the filling.
 - c. Service Temperature: Minus 50 to plus 200 deg F.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Ductmate Industries, Inc., model Proflex.
 - b. Ventfabrics, Inc., model Ventlon.

2.11 INSULATION MATERIALS

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. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
6. 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.
7. [Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

B. Insulation Materials:

1. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Aeroflex USA, Inc.
 - 2) Armacell LLC.
 - 3) K-Flex USA.
2. Mineral-Fiber, Preformed Pipe Insulation:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Johns Manville; a Berkshire Hathaway company.

- 2) Knauf Insulation.
- 3) Manson Insulation Inc.
- 4) Owens Corning.
- b. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.
3. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Provide 2-inch wide stapling and taping flange.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) CertainTeed Corporation.
 - 2) Johns Manville.
 - 3) Knauf Insulation.
 - 4) Owens Corning.
- C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Design Polymerics.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Design Polymerics.
 - b. Childers Brand; H. B. Fuller Construction Products.
 - c. Foster Brand; H. B. Fuller Construction Products.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Design Polymerics.
 - b. Childers Brand; H. B. Fuller Construction Products.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Knauf Insulation.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.
- F. Field Applied Jackets:
1. PVC Jacket and Factory Fabricated Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Johns Manville, model Zeston, with Zeston 2000 fitting covers.
 - 2) Proto Corporation, model LoSmoke.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Childers Brand; H. B. Fuller Construction Products.
 - 2) ITW Insulation Systems; Illinois Tool Works, Inc.
 - 3) RPR Products, Inc.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
 - d. Factory-Fabricated 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.

2.12 THERMAL HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
1. Buckaroos, Inc.
 2. Carpenter & Paterson, Inc.
 3. Clement Support Services.
 4. Rilco Manufacturing Co., Inc.
- B. Flame-spread index of 25 or less and smoke-developed index of 50 or less as tested by ASTM E 84.
- C. Insulation-Insert Material for Cold or Hot Piping, from Minus 40 to Plus 275 Deg F: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 1126, Type III rigid phenolic foam and vapor barrier.
1. Phenolic:

- a. NPS 10 and Smaller: 3.75-lb/cu. Ft. minimum compressive strength.
- b. NPS 12 to NPS 30: 5.0-lb/cu. ft. minimum compressive strength.
- D. Insulation-Insert Material for Piping Above 275 Deg F: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- E. Insulation Protection Shields: Galvanized metal, G90 coating designation, complying with ASTM A 653/A 653M, 180-degree saddle.
- F. Heavy Duty Insulation Protection Shields: Galvanized metal, 12-gage, G90 coating designation, complying with ASTM A 653/A 653M, 180-degree saddle. Structural steel plate welded to bottom of galvanized shield for sizes NPS 6 and larger.
- G. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- H. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- I. Insert Length: Extend minimum 1-1/2 inches beyond sheet metal shield.

2.13 TEMPERATURE CONTROL SYSTEM

- A. Refer to Section 23 09 23, Direct Digital Control System for HVAC.

EXECUTION

3.01 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.

3.02 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.

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. Where field assembled refrigerant piping is exposed mounted at grade, on walls, and on roof, enclose in 16 gage galvanized steel enclosure.
4. 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.

3.03 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.

3.04 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.

3.05 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 access door with 1/2 inch high minimum stenciled letters.

3.06 TEMPORARY FILTERS

- A. Provide temporary filters for fans that are operated during construction; after 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.

3.07 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.

3.08 DUCTWORK INSTALLATION

- A. General:
 - 1. 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.
 - 2. Duct Joints: Install duct sealers, pop rivets or sheet metal screws at each fitting and joint. Duct sealers shall be fire retardant. Sheet metal screws for joints shall be minimum #10 size galvanized.
 - 3. Where 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.
 - 4. Horizontal runs of 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.
 - 5. Provide sheet metal angle frame at all duct penetrations to wall, floor, roof, or ceiling.
 - 6. Paint inside of ducts, visible through grille, dull black.
 - 7. 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.
 - 8. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, duct and other related air

distribution component openings shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency.

B. Firestopping:

1. Pack the annular space between duct openings and ducts penetrating 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. Firestopping systems to be installed in strict accordance with manufacturer's instructions.
3. 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.

- 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

- 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. Flexible duct bends shall be not less than 1-1/2 duct diameter bend radius.
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.

3.09 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 "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 230050, "Basic HVAC Materials and Methods," Article, "Acceptance Requirements."

3.10 PIPING 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 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 conduits 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. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
8. Verify final equipment and fixture locations for roughing-in.
9. 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.
10. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
11. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
12. 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.
13. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.

B. 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.

C. 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.

D. Firestopping:

1. Pack the annular space between pipe sleeves and pipes penetrating 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, or equal, plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
5. 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.

3.11 HANGER AND SUPPORT INSTALLATION

- A. 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. 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.
 - 1. Materials, design, and type numbers for support of piping per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
 - a. Provide copper-plated or felt-lined hangers for use on uninsulated copper tubing.
 - 2. Materials and design for ductwork support shall be per SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
- B. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.
- C. Riser clamps: B-line model B3373, or equal.
- D. Rubber Neoprene Pipe Isolators:
 - 1. 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.
 - 2. 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.
 - 3. Manufacturers:
 - a. Vertical runs: Acousto-Plumb or equal.
 - b. Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.
- E. Pipe Hanger and Support Placement and Spacing:
 - 1. 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.
 - 2. Vertical piping hanger and 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</u>	<u>Copper Brazed or Soldered</u>	<u>CPVC & PVC (Note 2)</u>
	<u>(Note 3)</u>	<u>(Notes 3, 4)</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)

- a. Note 1: Provide mid-story guides.
 - b. 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.
 - c. Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
 - d. Note 4: Includes refrigerant piping, including vapor and hot gas pipes.
3. 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</u>	<u>Copper Brazed or Soldered</u>	<u>CPVC & PVC (Note 1)</u>
	<u>(Note 2)</u>	<u>(Notes 2, 3)</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.

- a. 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.
 - b. Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
 - c. Note 3: Includes refrigerant piping, including vapor and hot gas pipes.
4. 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. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.
- c. Trapeze Suspension: B-Line, or equal, 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, or equal. Where used for seismic support systems, provide B-Line B2400 series, or equal, pipe straps.
- f. Concrete Inserts: B-line B22-1 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.
5. Insulated Piping:
 - a. Do not interrupt insulation at pipe hangers and clamps.
 - b. Use thermal hanger shield inserts or MSS protection saddles and shields.
 - c. Thermal Hanger Shield Inserts:
 - 1) Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 2) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 3) For below ambient services, maintain continuous vapor barrier.
 - 4) For Clevis or Band Hangers: Install thermal-hanger shield inserts with insulation protection shields.
 - 5) For Trapeze or Clamped Systems: Install thermal-hanger shield inserts with heavy-duty insulation protection shields. Install additional 180-degree galvanized shield for top of support if clamping is required.
 - d. MSS Protection Saddles and Shields:
 - 1) MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 2) MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 3) Shield Dimensions for Pipe: Of length recommended in writing by manufacturer to prevent crushing insulation. Not less than the following:
 - a) NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b) NPS 4: 12 inches long and 0.06 inch thick.
 - c) NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d) NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e) NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

F. Piping Support to Structure:

1. 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.

G. Duct Hanger and Support Spacing: Conform to Requirements of CMC and SMACNA "HVAC Duct Construction Standards, Metal and Flexible."

H. Duct Support to Structure:

1. 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

2. 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

3. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.
4. Upper connection to manufactured truss construction must comply with truss manufacturers published requirements and Structural Engineers requirements.

3.12 INSULATION AND FIELD-APPLIED JACKET INSTALLATION

A. General:

1. The term "piping" used herein includes pipe, air separators, valves, strainers and fittings.
2. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.
3. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, ductwork, and equipment.
4. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
5. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
6. Install insulation with longitudinal seams at top and bottom of horizontal runs.
7. Install multiple layers of insulation with longitudinal and end seams staggered.

8. Keep insulation materials dry during application and finishing.
 9. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
 10. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
 11. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 12. For piping, ductwork, and equipment, with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
 13. Repair all damage to existing pipe, duct 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.
 14. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - a. Install insulation continuously through hangers and around anchor attachments.
 - b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - d. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- B. Piping Insulation Installation:
1. General:
 - a. 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.
 - b. Provide removable insulation covers for items requiring periodic service or inspection.
 - c. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation.
 - d. Provide pre-formed PVC valve and fitting covers for indoor piping.
 - e. Provide factory-fabricated aluminum valve and fitting covers for outdoor piping.
 - f. 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.
 2. Below-Ambient Services Including Chilled Water Supply and Return and Refrigerant Piping:
 - a. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of woven glass fiber cloth saturated in Foster Sealfas 30-36,

3M, or equal, extending 3 inches over the adjoining pipe insulation. Finish with a coat of Foster 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.

- b. Variable refrigerant flow (VRF) heat pump systems: Insulation for VRF system refrigerant piping shall be installed according to VRF unit manufacturer's instructions.
- 3. PVC Jacket Installation:
 - a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- 4. Aluminum Jacket Installation:
 - a. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. 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.
 - b. Do not install aluminum jackets on refrigerant flexible connectors to vibration isolated outdoor condensing units. Coat elastomeric insulation with insulation manufacturer's recommended ultraviolet light protective coating.
- C. Duct Insulation Installation:
 - 1. General:
 - a. 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.
 - b. Duct insulation applied to the exterior surface of ducts installed outside the building insulation envelope shall meet minimum R-value of R-8 at 3 inches thickness and 3/4 pound per cubic foot density.
 - c. Duct insulation applied to the exterior surface of ducts installed within the building insulation envelope shall meet minimum R-value of R-4.2 at 1-1/2 inches thickness and 3/4 pound per cubic foot density.
 - 2. Mineral Fiber Blanket Installation:
 - 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 offacing

with scrim backed foil tape or recommended sealant, to provide a vapor tight installation.

3. PVC Jacket Installation:

- a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.13 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.

3.14 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.

3.15 TESTING AND BALANCING

- A. For testing and balancing requirements, refer to Section 23 05 93, Testing and Balancing for HVAC.

3.16 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.

3.17 EQUIPMENT MOUNTING

- A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

3.18 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping, Cooling-Only Systems:
 - 1. Suction and hot-gas piping smaller than 1-1/2 inches diameter:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1/2 inch thick.
 - 2. Suction piping 1-1/2 inches diameter and larger:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1 inch thick.
- B. Refrigerant Vapor and Liquid Piping, Heat Pump Systems:
 - 1. Vapor piping for heat pump applications smaller than 1-1/2 inches diameter:
 - a. Flexible Elastomeric: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe: 1-1/2 inches thick.
 - 2. Vapor piping for heat pump applications 1-1/2 inches diameter and larger:
 - a. Flexible Elastomeric: 2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe: 2 inches thick.
 - 3. Liquid piping for heat pump applications smaller than 1 inch diameter:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1 inch thick.
 - 4. Liquid piping for heat pump applications 1 inch diameter and larger:
 - a. Flexible Elastomeric: 1-1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1-1/2 inch thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping, Cooling-Only Systems:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1 inch thick.
- B. Refrigerant Vapor and Liquid Piping, Heat Pump Systems:
 - 1. Vapor piping for heat pump applications smaller than 1-1/2 inches diameter:
 - a. Flexible Elastomeric: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe: 1-1/2 inches thick.
 - 2. Vapor piping for heat pump applications 1-1/2 inches diameter and larger:
 - a. Flexible Elastomeric: 2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe: 2 inches thick.
 - 3. Liquid piping for heat pump applications smaller than 1 inch diameter:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1 inch thick.
 - 4. Liquid piping for heat pump applications 1 inch diameter and larger:
 - a. Flexible Elastomeric: 1-1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe: 1-1/2 inch thick.
- C. Refrigerant Flexible Connectors:
 - 1. Flexible Elastomeric: Thicknesses as specified for rigid piping.

3.20 INDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

- A. Piping, concealed: None.
- B. Piping, exposed: PVC, 20 mils thick.

3.21 OUTDOOR FIELD-APPLIED PIPING JACKET SCHEDULE

- A. All Piping: Aluminum, Stucco Embossed: Thickness as follows:

<u>Outer Insulation Diameter</u> <u>(Inches)</u>	<u>Minimum Aluminum Jacket Thickness</u>	
	<u>(Inch)</u>	
	<u>Rigid Insulation</u>	<u>Non-Rigid Insulation</u> <u>(Note 1)</u>
8 and Smaller	0.024	0.024
Larger Than 8 Thru 11	0.024	0.024
Larger Than 11 Thru 24	0.024	0.024
Larger Than 24 Thru 36	0.024	0.032
Larger Than 36	0.024	0.040

1. Note 1: Non-rigid Insulation is defined as having a compressive strength of less than 15 psi.

3.22 INDOOR DUCT INSULATION SCHEDULE

- A. Ducts Located Within Building Thermal Envelope:
 1. Minimum R-Value = R-4.2.
 2. Supply and Return Ducts: Mineral Fiber Blanket, 1-1/2 inches thick, 0.75 lb/cu. ft.
- B. Ducts Located Within Building Outside Thermal Envelope:
 1. Minimum R-Value – R-8.0.
 2. Supply and Return Ducts: Mineral Fiber Blanket, 3 inches thick, 0.75 lb/cu. ft.

3.23 OUTDOOR DUCT INSULATION SCHEDULE.

- A. Minimum R-Value = R-8.
- B. Refer to article, Ductwork, for internal duct lining. Provide 2 inches thick internal duct lining where indicated on Drawings.

3.24 INDOOR FIELD-APPLIED DUCT JACKET SCHEDULE

- A. Insulated ducts in concealed spaces: None.
- B. Insulated ducts in exposed unconditioned spaces: PVC, 20 mils thick.

END OF SECTION 23 80 00

SECTION 260010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Table of Contents, Division 26 - Electrical:

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<u>260010</u>	<u>BASIC ELECTRICAL REQUIREMENTS</u>
<u>260060</u>	<u>POWER SYSTEM STUDY</u>
<u>260090</u>	<u>ELECTRICAL DEMOLITION</u>
<u>260513</u>	<u>MEDIUM-VOLTAGE CABLES</u>
<u>260519</u>	<u>BUILDING WIRE AND CABLE</u>
<u>260526</u>	<u>GROUNDING AND BONDING</u>
<u>260529</u>	<u>ELECTRICAL HANGERS AND SUPPORTS</u>
<u>260531</u>	<u>CONDUIT</u>
<u>260533</u>	<u>BOXES</u>
<u>260536</u>	<u>CABLE TRAYS</u>
<u>260539</u>	<u>UNDERFLOOR DUCTS</u>
<u>260543</u>	<u>UNDERGROUND DUCTS AND STRUCTURES</u>
<u>260553</u>	<u>ELECTRICAL IDENTIFICATION</u>
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<u>260926</u>	<u>RELAY PANEL LIGHTING CONTROL</u>
<u>260942</u>	<u>DIGITAL LIGHTING CONTROL</u>
<u>260943</u>	<u>NETWORK ADDRESSABLE LIGHTING CONTROL</u>
<u>261013</u>	<u>AERIAL POWER DISTRIBUTION</u>
<u>261113</u>	<u>PRIMARY UNIT SUBSTATION</u>
<u>261116</u>	<u>SECONDARY UNIT SUBSTATIONS</u>
<u>261219</u>	<u>PAD-MOUNTED TRANSFORMERS</u>
<u>261223</u>	<u>SUBSURFACE-MOUNTED TRANSFORMERS</u>
<u>261313</u>	<u>PRIMARY SERVICE SWITCHGEAR</u>
<u>261316</u>	<u>LOAD INTERRUPTER SWITCHGEAR</u>
<u>261323</u>	<u>MEDIUM-VOLTAGE AUTOMATIC TRANSFER SWITCHES</u>
<u>262213</u>	<u>DRY TYPE TRANSFORMERS</u>
<u>262313</u>	<u>GENERATOR CONTROLS & PARALLELING SWITCHGEAR</u>
<u>262413</u>	<u>SWITCHBOARDS</u>
<u>262416</u>	<u>PANELBOARDS</u>
<u>262419</u>	<u>INTEGRATED DISTRIBUTION ASSEMBLIES</u>
<u>262423</u>	<u>SERVICE PEDESTALS</u>
<u>262500</u>	<u>BUSWAY</u>
<u>262513</u>	<u>TRACK BUSWAY SYSTEM</u>
<u>262600</u>	<u>POWER DISTRIBUTION UNIT</u>
<u>262716</u>	<u>CABINETS AND ENCLOSURES</u>
<u>262719</u>	<u>SURFACE RACEWAYS</u>
<u>262726</u>	<u>WIRING DEVICES</u>
<u>262733</u>	<u>POWER AND ENERGY SUBMETERING</u>
<u>262736</u>	<u>ENERGY INFORMATION SYSTEMS</u>
<u>262816</u>	<u>OVERCURRENT PROTECTIVE DEVICES</u>
<u>262819</u>	<u>DISCONNECT SWITCHES</u>

<u>262900</u>	<u>MOTOR CONTROLS</u>
<u>263100</u>	<u>PHOTOVOLTAIC POWER SYSTEMS</u>
<u>263213</u>	<u>PACKAGED ENGINE GENERATOR SYSTEM</u>
<u>263323</u>	<u>CENTRAL BATTERY INVERTER SYSTEM</u>
<u>263356</u>	<u>MULTIPLE STATIC UNINTERRUPTIBLE POWER SUPPLY</u>
<u>263623</u>	<u>TRANSFER SWITCHES</u>
<u>263633</u>	<u>AUTOMATIC STATIC TRANSFER SWITCH</u>
<u>264113</u>	<u>LIGHTNING PROTECTION SYSTEM</u>
<u>264313</u>	<u>SURGE PROTECTIVE DEVICES</u>
<u>265000</u>	<u>LIGHTING</u>

B. Work included: This Section includes general administrative and procedural requirements for Division 26. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Project management and coordination services.
8. Contract modification pricing procedures.
9. Excavation.
10. Rough-in.
11. Electrical installation.
12. Cutting, patching, painting, and sealing.
13. Field quality control.
14. Cleaning.
15. Project closeout.
16. Interface/Responsibility Matrix.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 26 Sections.
2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, lighting pole foundations, etc. Refer to Division 31, Earthwork.

3. **Selective demolition: Nondestructive removal of materials and equipment for reuse or salvage as indicated. Also dismantling electrical materials and equipment made obsolete by these installations. Refer to Division 02, Selective Demolition.**
 4. Concrete work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, lightpole foundations, pull box slabs, vaults, housekeeping pads, etc. **Also includes setting of floor boxes in existing concrete slabs, saw-cutting of existing slabs and grouting of conduits in saw-cut.** Refer to Division 03, Concrete.
 5. Miscellaneous metal work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, luminaires, panelboards, distribution boards, switchboards, motor control centers, etc. Refer to Division 05, Miscellaneous Metals.
 6. Miscellaneous lumber and framing work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of electrical materials and equipment. Refer to Division 06, Rough Carpentry.
 7. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. Refer to Division 07, Thermal and Moisture Protection.
 8. Access panels and doors: Required in walls, ceilings, and floors to provide access to electrical devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 9. Painting: Include surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
 10. Luminaire supports: Provide slack support wire for luminaires installed in acoustical tile or lay-in suspended ceilings. Refer to Division 09, Acoustical Treatment.
- D. Work furnished and installed under another Division requiring connections under this Division includes but is not limited to:**
1. **Electric motors.**
 2. **Package mechanical equipment: fans, fan coil units, pumps, boilers, compressors, etc.**
 3. **Flow switches and valve monitors for sprinkler system.**
 4. **Elevator controllers.**
 5. **Pre-wired electrified partition furniture.**
 6. **Temperature control panel(s). (Line voltage only)**
 7. **Irrigation controller(s). (Line voltage only)**
 8. **EM-200 control panel. (Line voltage only)**
 9. **Kitchen equipment and appliances.**
 10. **Laboratory equipment.**

11. Electric signage.
 12. Electric door locks.
 13. Electric heat trace tape.
 14. Door hold-open/release devices.
 15. Variable frequency drive units.
 16. Chiller starters.
 17. Motorized roll down/sliding doors and grills.
 18. Motorized dock levelers.
 19. Projection screens.
- E. Items furnished under this Division, but installed and connected under another Division includes but is not limited to:
1. Diesel generator day tank. (Division 22)
 2. Diesel generator silencer. (Division 23)
 3. Generator daytank fuel strainer, manual fuel pump, check valve and any other specified accessories. (Division 22)
 4. Remote radiator for generator. (Division 22)
- F. Items furnished under another Division, but installed and connected under this Division includes but is not limited to:
1. Wall mounted control stations for motorized roll down and sliding doors.
 2. Electric fire sprinkler water flow bells.
 3. Speed control switches for ceiling exhaust fans.

1.02 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.
- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
1. California Electrical Code (CEC).
 2. California Building Code (CBC).
 3. California Fire Code (CFC).
 4. California Mechanical Code (CMC).

- D.** Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
CBM	Certified Ballast Manufacturers
FS	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IPCEA	Insulated Power Cable Engineer Association
NEMA	National Electrical Manufacturer's Association
UL	Underwriters' Laboratories

- E.** Independent Testing Agency qualifications:

1. Testing Agency shall be an independent testing organization that will function as an unbiased authority, professionally independent of Manufacturer, Supplier and Contractor, furnishing and installing equipment or system evaluated by Testing Agency.
2. Testing Agency shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
3. Testing Agency shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories, Title 9, Part 1907.
4. On-site technical personnel shall be currently certified by the International Electrical Testing Association in electrical power distribution system testing.
5. Testing Agency shall use technicians who are regularly employed by the firm for testing services.
6. Contractor shall submit proof of above Testing Agency qualifications with bid documentation upon request.

- F.** All base material shall be ASTM and/or ANSI standards.

- G.** All electrical apparatus furnished under this Section shall conform to NEMA standards and the CEC and bear the UL label where such label is applicable.

- H.** Certify that each welder performing Work has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

1.03 DEFINITION OF TERMS

- A.** The following list of terms as used in the Division 26 documents shall be defined as follows:

1. "Provide": Shall mean furnish, install, and connect unless otherwise indicated.
2. "Furnish": Shall mean purchase and deliver to Project site.
3. "Install": Shall mean to physically install the items in-place.
4. "Connect": Shall mean make final electrical connections for a complete operating piece of equipment.
5. "As directed": Shall be as directed by the Owner or their authorized Representative.

- 6. "Utility Companies":** Shall mean the company providing electrical, telephone or cable television services to the Project.

1.04 SUBMITTALS

- A.** Format: Furnish submittal data in electronic (.pdf) format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B.** Source and Quality: Submittals shall be generated directly from the manufacturer's electronic documentation and shall maintain full text searchability. Scanned, photocopied, or otherwise non-searchable documents will not be accepted.
- C.** Legibility: All submitted documents shall be of high resolution, clearly legible, and free from distortions, artifacts, or other quality deficiencies that could impair readability.
- D.** Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- E.** Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.
- F.** The Contractor shall submit detailed Drawings of all electrical equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of electrical equipment indicated on the Drawings shall match those of the electrical equipment that is being submitted for review, i.e.: switchboards, panelboards, transformers, control panels, etc. Minimum scale: 1/4" = 1'- 0". Revised electrical equipment layouts must be approved prior to release of order for equipment and prior to installation.
- G.** As part of the equipment and fixture submittals, the Contractor shall provide anchorage calculations for floor and wall mounted electrical equipment and fixtures, distribution conduits and raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

- H. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
- I. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
- J. All resubmittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Resubmittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

1. Manufactured wiring system. Section 260519.

2. Fire alarm system. Section 266113.

3. FM200/preaction fire suppression interface. Section 266213.

4. Two-way communication system. Section 266226.

5. Distributed antenna systems (DAS) for ERRCs. Section 266316.

- K. Independent Testing Agency report:

- 1. Testing Agency shall provide 3 copies of the complete testing report.
- 2. Test report shall include the following:
 - a. Summary of Project.
 - b. Description of equipment.
 - c. Equipment used to conduct the test.
 - 1) Type.
 - 2) Manufacturer.
 - 3) Model number.
 - 4) Serial number.
 - 5) Date of last calibration.
 - 6) Documentation of calibration leading to NIST standards.
 - d. Description of test.
 - e. Test results, as compared to Manufacturers or industry accepted standards and tolerances.
 - f. Conclusion and recommendation.
 - g. Signature of responsible test organization authority.
- 3. Furnish completed test report to Engineer no later than 30-days after completion of testing, unless otherwise directed.

- L. Substitutions:

- 1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.

2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility, and appearance, will be approved as substitutions to that specified.
4. Whenever any material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.05 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the Electrical Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover fixtures, equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Preparation:

1. Drawings:

- a. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
- b. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.

D. Utility company contacts:

1. **Contact for electrical service:**
2. **Contact for telephone service:**
3. **Contact for television service:**

1.06 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of outlets, true panelboard connections following phase balancing routines, correct conduit, and wire sizing as well as routing, revised luminaire schedule listing Manufacturers and products installed and revised panel schedules. Contractor shall record all changes in the Work during the course of construction on blue or black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not current, monthly payments may be withheld.
2. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. **All underground installation.**
 - b. **Building electrical rough-in.**

- c. Final electrical installation.
- 3. Include in the record drawing submission the following shop drawing submission with all updated installation information:
 - a. Manufactured wiring system.
 - b. Fire alarm system.
 - c. FM200/pre-action fire suppression interface.
 - d. Two-way communication system.
 - e. Distributed antenna system (DAS) for ERRCS.
- 4. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. Two sets of full-size prints.
 - b. Four sets of half-size prints.
 - c. One set of full size reproductions.

B. Panel schedules:

- 1. Typewritten panel schedules shall be provided for panelboards indicating the loads served and the correct branch circuit number. Schedules shall be prepared on forms provided by the Manufacturer and inserted in the pocket of the inner door of each panelboard. See Section 262416: Panelboards for requirements.
- 2. A single set of the record panel schedules shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. Fold and insert one copy of the appropriate schedule in the pocket of the inner door of each panelboard.
 - b. Three binders, each containing a full set of the panel schedules. Provide index listing all schedules and dividers for separation of schedules as follows:

1) 277/480V normal.

- 1) 277/480V emergency.
- 2) 277/480V legally required standby.
- 3) 277/480V optional standby.
- 4) 277/480V critical.
- 5) 277/480V life safety.
- 6) 277/480V equipment.
- 7) 277/480V generator equipment.
- 9) 120/208V normal.
- 10) 120/208V emergency.
- 11) 120/208V legally required standby.
- 12) 120/208V optional standby.

- 13) 120/208V critical.
- 14) 120/208V life safety.
- 15) 120/208V equipment.
- 16) 120/208V generator equipment.

C. Field labels, markings, and warning signs: Provide in accordance and as required by:

- 1. General: CEC Article 110.21.
- 2. High-Leg System: CEC Article 110.15.
- 3. Arc-Flash Hazard Warning: CEC Article 110.16 (A).
- 4. Service Equipment: CEC Article 110.16 (B).
- 5. Identification of Disconnecting Means: CEC Article 110.22 (A).
- 6. Engineered Series Combination Systems: CEC Article 110.22 (B).
- 7. Tested Series Combination Systems: CEC Article 110.22 (C).
- 8. Available Fault Current: CEC Article 110.24.
- 9. Depth of Working Space in Existing Buildings: CEC Article 110.26 (A)(1)(c).
- 10. Guarding of Live Parts: CEC Article 110.27 (C).
- 11. Locked Rooms or Enclosures: CEC Article 110.34 (C).
- 12. Manholes: CEC Article 110.75 (E).
- 13. Identification for Branch Circuits: CEC Article 210.5.
- 14. Identification for Feeders: CEC Article 215.12.
- 15. Switchboard, Switchgear, and Panelboard Identification: CEC Article 408.3.
- 16. Field Identification Required: CEC Article 408.4.
- 17. Short-Circuit Current Rating: CEC Article 408.6.
- 18. Industrial Control Panels: CEC Article 409.22.
- 19. MCC: CEC Article 430.99.
- 20. Air Conditioning and Refrigeration Equipment: CEC Article 440.10.
- 21. Elevators (and other similar equipment): CEC Article 620.65.
- 22. Emergency Systems: CEC Article 700.7.
- 23. Legally Required Standby Systems: CEC Article 701.7.
- 24. Optional Standby Systems: CEC Article 702.7.
- 25. Interconnected Electric Power Production Sources: CEC Article 705.10.
- 26. Direct Current Microgrids: CEC Article 712.10.

1.07 OPERATION AND MAINTENANCE MANUALS

- A.** Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all

equipment furnished under Division 26. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

1.08 PROJECT MANAGEMENT AND COORDINATION SERVICES

- A. Overview: Contractor shall provide a Project Manager/Engineer for the duration of the Project to coordinate the Division 26 Work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this Section.
- B. Review of Shop Drawings prepared by other Subcontractors:
 - 1. Obtain copies of all Shop Drawings for equipment provided by others that require electrical service connections or interface with Division 26 Work.
 - 2. Perform a thorough review of the Shop Drawings to confirm compliance with the service requirements contained in the Division 26 Contract Documents. Document any discrepancy or deviation as follows:
 - a. Prepare memo summarizing the discrepancy.
 - b. Provide a copy of the specific shop drawing indicating via cloud, the discrepancy.
 - 3. Prepare and maintain a shop drawing review log indicating the following information:
 - a. Shop drawing number and brief description of the system/material.
 - b. Date of your review.
 - c. Indication if follow-up coordination is required.
- C. Request for information (RFI):
 - 1. Thoroughly review the Contract Documents prior to the preparation and submission of an RFI. If an RFI is submitted, attach 8 1/2" x 11" copies of all relevant documents to clarify the issue.
 - 2. Prepare and maintain an RFI log indicating the following information:
 - a. RFI number and brief summary of the issue.
 - b. Date of issuance and receipt of response.
- D. Clarification confirmation memo (CCM):
 - 1. Either the Contractor will prepare CCM memos or the Engineer to confirm a decision clarifying the Contract Documents that does not impact cost or affect other trades.
 - 2. Prepare and maintain a CCM log indicating the following information:
 - a. CCM number: Use CCM-C1, C2, etc. for memos issued by the Contractor and CCM-E1, E2, etc. for memos issued by the Engineer.
 - b. Brief summary of issue and date issued.

1.09 CONTRACT PRICING MODIFICATION PROCEDURES

- A. Submission guidelines: This Section covers the criteria for direct costs, mark-ups, and documentation requirements to be followed by the Contractor for any pricing modification to the Base Contract, where unit pricing has not already been established.

1. Change orders: Pricing for additions or deletions to the Base Contract Scope of Work upon acceptance of bid value and receipt of authorization to proceed.
2. Allowances: Cost allowances may be assigned for specific Scope of Work outlined within the Base Contract where design has not been fully delineated on the Contract Documents. When detailed information is available, the Contractor shall prepare and submit a price quotation for the Work. This price quotation will be compared to the allowance value and any adjustments necessary to the Base Contract value shall be made via change order.

B. Direct costs:

1. Labor:

- a. Hourly labor rates shall not exceed the prevailing wage for the County where the Work is being performed. The costs for all supervision, including general superintendents and foremen, shall be included in the mark-up defined herein. Working foremen will be considered a direct cost only if the individual is on the Project site physically installing Work under the change order.
- b. Labor burden shall be based on rates currently in effect at the time the Work under the change order is being performed and shall include only fringe benefits by governing trade organizations, Federal Insurance Contribution Act, Federal and State Unemployment taxes, payroll taxes and net actual premium paid for public liability, workers' compensation, property damage and other forms of insurance required by the Owner. No other cost will be included as labor burden.
- c. NECA Manual of Labor Units will be utilized as the basis for determining labor productivity rates for Electrical Work as follows:
 - 1) 85% of NECA column 1 (normal) for change in scope issued well in advance of Work needing to be performed, so as not to cause slow-down or Work stoppage.
 - 2) 100% of NECA column 1 (normal) for Work being performed with other Base Contract Work, not out of sequence and with minimal slow-down or Work stoppage.
 - 3) 100% of NECA column 2 (difficult) for Work performed out of sequence, requiring Work stoppage and reconstruction in areas already complete. This Work may involve the removal of ceiling tiles or the cutting and patching of walls.
- d. No labor costs shall be included for the following items since the labor is already covered by the NECA labor units for conduit and construction channel:
 - 1) Conduit straps and clips.
 - 2) Construction channel accessories (nuts, washers, etc.).
 - 3) Screws.
 - 4) Conduit elbows ¾" and smaller.

2. Material:

- a. The cost of material shall be the direct cost, including sales tax and may include the cost of transportation from the Supplier to the Contractor, but charges for final delivery to the Project site will not be allowed.

- b. Electrical commodities priced based on most current Trade Service Book with a 15% discount. Non-commodities priced per invoice from Supplier.

3. Equipment rental:

- a. Payment for equipment costs will be made at the rental rates listed for such equipment as specified in the current edition, at the time of the Work, of "Labor Surcharge and Equipment Rental Rates," a Caltrans Publication. Such rental rates shall be adjusted as appropriate and will be used to compute payments for equipment; regardless of the whether the equipment is under Contractor's control through direct ownership, leasing, renting or other method of acquisition. Daily, weekly, or monthly rates shall be used, whichever is lower. Hourly rates including operator shall not be used.
 - b. The actual time to be paid for equipment shall be the time the equipment is in productive operation on the Work. No payment will be made time while equipment is inoperative due to breakdown or for non-working days.
 - c. Individual pieces of equipment having a replacement value of \$1,000 or less shall be considered small tools or small equipment and no payment will be made since the costs of these tools and equipment are included as part of the Contractor's mark-up for overhead and profit.
 - d. Payment to Contractor for use of equipment as set forth herein shall constitute full compensation to Contractor for the cost of fuel, power, oil, lubricants, supplies, small equipment, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, labor (except for equipment operators) and any and all costs to Contractor for incidental use of the equipment.
4. Performance bond: Only the actual cost of insurance and bond premiums, with no mark-up for overhead and profit, will be allowed.

C. Mark-up for overhead and profit on direct costs:

1. Costs to be included as part of mark-up:

- a. Field and home office personnel including, but not limited to, Principals, Project Managers, Superintendents, Supervisory Foremen, Estimators, Project Engineers, Detailers, Draftspersons, Schedulers and Administrative Assistants.
- b. All field and home office expenses including, but not limited to, field trailers, parking, storage sheds, office equipment and supplies, telephone service at the Project site, long-distance telephone calls, fax machines, computers and software, temporary utilities, sanitary facilities, etc.
- c. Administrative functions including, but not limited to, reviewing, coordinating, distributing, processing, posting, recording, estimating, negotiating, scheduling, schedule updating and revising, expediting, detailing, revising Shop Drawings and preparing Record Drawings.
- d. Vehicles required for the transportation of Contractor's staff and field personnel.

2. Maximum mark-up values:

- a. For Work performed by the Contractor, the overhead mark-up shall equal a maximum of 10 percent of the direct costs, as defined herein.

- b. Mark-up for profit shall equal a maximum of 5 percent of combined direct and overhead costs.
- c. For Work performed by a Subcontractor shall equal a maximum of 5 percent mark-up for profit. Subcontractor shall follow the same guidelines above for their mark-up allowance. No consideration shall be given for more mark-ups then this two-tier arrangement whereas the mark-up could excess 20%.
- d. For Work scope changes that result in a net decrease in cost to the Contractor or a Subcontractor, the Owner shall receive a credit based on the actual net decrease in direct cost figured in the same manner as an add cost. It is understood that the mark-up value applied at bid time will not be credited back. Although, if this is a change to a previous change order, then mark-up values shall be included in credit back to Owner.
- e. There will be no mark-ups on the cost of performance bond.

D. Documentation:

- 1. Project change order request submission:
 - a. Provide copies of all take-off sheets showing material and labor charges in line item format.
 - b. Provide recap sheet showing all direct costs and mark-ups.
 - c. Provide copies of invoices for Subcontracted Work.
- 2. Allowance account tracking:
 - a. Contractor shall prepare and maintain a spreadsheet for each allowance account to track and monitor the requested and approved charges.
 - b. Copies of these spreadsheets, along with the summary spreadsheets, shall be submitted to the Owner's Representative twice a month.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXCAVATION

- A. General: Cutting and digging shall be under the direct supervision of the General Contractor and included as necessary for the Work of this Section.
- B. Excavation for underground vaults and electrical structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10-foot; plus, a sufficient distance to permit placing and removal of concrete formwork, installation or services, other construction and for inspection.
 - 1. Excavate, by hand, areas within dripline of large trees. Protect the root system for damage and dry-out. Maintain moist conditions for root system and over exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- C. Trenching: Excavate trenches for electrical installation as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearances on both side of raceways and equipment.
 2. Excavate trenches to depth indicated or required.
 3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
- D. Backfilling: Place soil materials in layers to required subgrade elevations for each area classification, using materials and methods specified in Division 31, Earthwork.
1. Under building slabs, use drainage fill materials.

3.02 ROUGH-IN

- A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- B. Verify final locations for rough ins with field measurements and with the requirements for the actual equipment to be connected.
- C. Refer to equipment specification in Divisions 22 through 33 for rough-in requirements.

3.03 ELECTRICAL INSTALLATION

- A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Comply with the following requirements:
 1. Shop Drawings prepared by Manufacturer.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
 6. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
 7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Coordinate electrical systems, equipment, and materials installations with other building components.
12. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
13. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.
14. Conform to the National Electrical Contractors Association "Standard of Installation" for general installation practice.

3.04 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. **Cut, remove, and legally dispose of selected electrical equipment, components and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.**
- D. **Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.**
- E. **Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.**
- F. **Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.**
- G. Application of joint sealers:
 1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.05 FIELD QUALITY CONTROL

A. General testing requirements:

1. The purpose of testing is to ensure that all tested electrical equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
2. Tests and inspections shall determine suitability for energization.
3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.
4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.

B. Tests: In addition to specific system test described elsewhere, tests shall include:

1. Equipment operations: Test motors for correct operation and rotation.
2. Lighting control circuits: Test lighting circuits for correct operation through their control devices.
3. Alarm and interlock systems: Produce malfunction symptoms in operating systems to test alarm and interlock systems. In addition, all specific tests described in the fire alarm system shall be performed.
4. Circuit numbering verification: Select on a random basis, various circuit breakers within the panelboards and cycle them on and off to verify compliance of the typed panel directories with actual field wiring.
5. Voltage check:
 - a. At completion of job, check voltage at several points of utilization on the system that has been installed under this Contract. During test, energize all installed loads.
 - b. Adjust taps on transformers to give proper voltage, which is 118 to 122 volts for 120 volt nominal systems and proportionately equivalent for higher voltage systems. If proper voltage cannot be obtained, inform the Owner and the serving Utility Company.

C. Contractor shall provide test power required when testing equipment before service energization and coordinate availability of test power with General Contractor after service energization. The Contractor shall provide any specialized test power as needed or specified herein.

D. Testing safety and precautions:

1. Safety practices shall include the following requirements:
 - a. Applicable State and Local safety operating procedures.

- b. OSHA.
- c. NSC.
- d. NFPA 70E.
- 2. All tests shall be performed with apparatus de-energized and grounded except where otherwise specifically required ungrounded by test procedure.
- E. Calibration of test equipment:
 - 1. Testing Agency shall have calibration program that assures test instruments are maintained within rated accuracy.
 - 2. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6-months maximum; Digital, 12-months maximum.
 - b. Laboratory instruments: 12-months.
 - c. Leased specialty equipment: 12-months where accuracy is guaranteed by lessor.
 - 3. Dated calibration labels shall be visible on test equipment.
 - 4. Records, which show date and results of instruments calibrated or tested, must be kept up to date.
 - 5. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
 - 6. Calibration standards shall be of higher accuracy than instrument tested.
 - 7. Equipment used for field testing shall be more accurate than instrument being tested.
- F. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- G. Notify Owner and Engineer one week in advance of any testing.
- H. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.
- I. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- J. Include all test results in the maintenance manuals.

3.06 CLEANING

- A. Prior to energizing of electrical equipment, the Contractor shall thoroughly clean the interior of enclosures from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all electrical equipment per Manufacturers

approved methods and materials. Remove paint splatters and other spots, dirt, and debris.

- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.07 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than **24**-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This **24**-hour training is in addition to any instruction time called out in the Specifications for specific systems, i.e., **Fire Alarm**, **Generator**, etc. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool type required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.
- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION

3.08 **INTERFACE / RESPONSIBILITY MATRIX**

INTERFACE / RESPONSIBILITY MATRIX							
System Equipment	Specified Under Division	Furnished Under Division	Installed Under Division	Conduit & Box Rough-in Under Division	Wired & Cabled Under Division	Terminated Under Division	Remarks
Fire Sprinkler System:							
Flow Switches	21	21	21	26	26	26	
Valve Monitors	21	21	21	26	26	26	
Post Indicating Valves	21	21	21	26	26	26	
Smoke Detection System:							
Duct-Mounted Detectors	26	26	23	26	26	25/26	1
In-Duct Mounted Detectors	26	26	23	26	26	26	2
Ceiling Mounted Detectors	26	26	26	26	26	26	

INTERFACE / RESPONSIBILITY MATRIX							
System Equipment	Specified Under Division	Furnished Under Division	Installed Under Division	Conduit & Box Rough-in Under Division	Wired & Cabled Under Division	Terminated Under Division	Remarks
Magnetic Door Hold Open/Release	08	08	26	26	26	26	3
Door Closures	08	08	08	26	26	26	4
Fire/Smoke Dampers:							
Motor Operated Dampers	23	23	23	25/26	25/26	25/26	5, 6
Smoke Detectors at Unducted FSD	26	26	26	26	26	26	7
Smoke Detectors at Ducted FSD	26	26	23	26	26	26	8
Area Coverage Smoke Detectors	26	26	26	26	26	26	9
HVAC Equipment:							
Package Mechanical Equipment	23	23	23	25/26	25/26	25/26	10
Chillers	23	23	23	25/26	25/26	25/26	10
VFD's, Field Mounted	23	23	26	25/26	25/26	25/26	10
Motors, 3 Phase	23	23	23	25/26	25/26	25/26	11
Motor Starters, 3 Phase	26	26	26	25/26	25/26	25/26	12
Motors, 1 Phase	23	23	23	25/26	25/26	25/26	11
Other Powered Equipment	23	23	23	25/26	25/26	25/26	11
Safety Disconnects	26	26	26	26	26	26	
Building Automation System (BAS):							
Central Control Workstation	25	25	25	25/26	25/26	25/26	13
Control Panels	25	25	25	25/26	25/26	25/26	13
Lighting Relay Panels	25	25	26	25/26	25/26	25/26	14
Low-Voltage Switches	26	26	26	26	26	26	
Emergency Generator System:							
Muffler and Exhaust	26	26	23	-	-	-	15
Generator Fuel System	22	22	22	22/26	22/26	22/26	16

INTERFACE / RESPONSIBILITY MATRIX							
System Equipment	Specified Under Division	Furnished Under Division	Installed Under Division	Conduit & Box Rough-in Under Division	Wired & Cabled Under Division	Terminated Under Division	Remarks
Irrigation Control System:							
Controllers	32	32	32	32/26	32/26	32/26	17
Control Valves	32	32	32	32	32	32	
Luminaire Seismic Safety Support Wires:							
Acoustical Tile Ceiling Areas	09	09	09	09	09	09	
Exposed Structure Areas	26	26	26	26	26	26	
Telecommunication System							
Incoming Service	27	Utility	Utility	26	Utility	Utility	
Riser Backbone	27	27	27	26	27	27	
Active Electronic Components	27	27	27	26	26/27	26/27	18
Patch Panels & Terminal Blocks	27	27	27	-	27	27	
Equipment Racks	27	27	27	-	-	-	
Terminal Backboards	27	06	06	-	-	-	
Cable Trays	27	26	26	-	27	-	
Workstation Modular Jacks	27	27	27	26	27	27	
Electrified Partition Sys. Interface	27	27	27	26	27	27	
Security Systems:							
Control Panels	28	28	28	26/28	26/28	26/28	19
Electric Door Locks or Strikes	08	08	08	26	28	28	
Alarm Contacts	28	28	28	26	28	28	
Panic Hardware	08	08	08	26	26/28	26/28	20
Remote Power Supplies	08/28	08/28	28	26	26/28	26/28	20
Request-to-Exit Devices	08	08	08	26	28	28	
Door Release Motion Sensors	28	28	28	26	28	28	

INTERFACE / RESPONSIBILITY MATRIX							
System Equipment	Specified Under Division	Furnished Under Division	Installed Under Division	Conduit & Box Rough-in Under Division	Wired & Cabled Under Division	Terminated Under Division	Remarks
Glass Break Detectors	28	28	28	26	28	28	
Motion Sensor Detector	28	28	28	26	28	28	
Card Readers and Controllers	28	28	28	26	28	28	
Intercom Station	28	28	28	26	28	28	
Fixed Position CCTV Cameras	28	28	28	26	28	28	
P/T/Z CCTV Cameras	28	28	28	26	26/28	26/28	20
CCTV Monitors	28	28	28	26	26/28	26/28	20
Parking Garage Controls:							
Roll-Down Overhead Doors	08	08	08	26/28	26/28	26/28	21
Parking Arm Control Gates	28	28	28	26/28	26/28	26/28	21
Loop Sensors	28	28	28	28	28	28	
Ticket Booth	28	28	28	26/28	26/28	26/28	21
Ticket Dispenser	28	28	28	26/28	26/28	26/28	21
Audio/Visual Systems:							
Equipment Racks	27	27	27	26/27	26/27	26/27	22
Power Receptacles	26	26	26	26	26	26	
Wall Mounted Audio Device	27	27	27	27	27	27	
Wall Mounted Control Device	27	27	27	27	27	27	
Custom Floor Boxes	27	27	27	26/27	26/27	26/27	22
Recessed Speakers	27	27	26/27	26	26	27	23
Surface or Pendant Speakers	27	27	27	26	26	27	
Projection Screens	11	11	11	26	26	26	
Pull Boxes	27	26	26	26	26	27	

MATRIX REMARKS	
1	These are sampling tube type smoke detector mounted exterior to HVAC ducts with sampling tubes extending across duct interior. Duct-mounted detectors are generally associated with HVAC supply fans required to initiate fan shutdown for units that supply over 2000 cfm. Division 25 shall terminate wiring within fan controller for equipment shutdown upon smoke detection. Division 26 shall make all other terminations related to this equipment via the fire alarm system.
2	These are spot type smoke detectors mounted within HVAC ducts, generally associated with fire/smoke dampers in a ducted system.
3	Division 26 shall wire device for both power and control via the fire alarm system. Local smoke detector(s) shall provide the initiation to fire alarm system, which shall activate the closure of doors.
4	Division 26 shall wire device for power and monitoring via the fire alarm system. Control will be internal to device from integral smoke detector. Fire alarm system shall monitor the smoke detector utilizing an addressable monitoring module for alarm initiation at the control panel.
5	Division 25 shall provide conduit, boxes, wiring, cabling, and terminations to fire/smoke dampers related to HVAC controls, if required. Division 26 shall provide conduit, boxes, wiring, cabling, and terminations to fire/smoke dampers related to power and control via the fire alarm system. For fire alarm control, Division 26 shall provide a programmable control relay as part of the fire alarm system at each fire/smoke damper.
6	If position monitoring is required at fire/smoke dampers, Division 23 shall furnish dampers with integral end switches for both open and closed position monitoring. Division 26 shall provide dual input addressable monitoring modules as part of fire alarm system to monitor end switches for annunciation at control panel.
7	Division 26 shall furnish and install spot type smoke detector(s), mounted over the wall penetration opening in front, and within 5 feet, of the fire/smoke damper. Quantities of detectors shall vary based on the opening size of penetration per NFPA 72.
8	These are the in-duct type smoke detectors as outlined above and shall be located within 5 feet of fire/smoke damper. Quantities of detectors shall vary based on the opening size of duct penetration per NFPA 72.
9	These are ceiling mounted spot type smoke detectors, providing full coverage of areas served by fire/smoke dampers, in lieu of the two methods outlined above for detection related to fire/smoke dampers.
10	Equipment shall be furnished with an integral main circuit breaker, OSHA lockout/tagout padlockable in OFF position capability, SCCR of 100,000 amps, and pre-wired control panel mounted on unit for chillers and packaged mechanical equipment. Division 25 shall provide conduit, boxes, wiring, cabling, and terminations to equipment related to HVAC controls. Division 23 shall provide externally mounted harmonic mitigating devices (e.g. line reactors, DV/DT filters, etc.). Division 26 shall provide conduit, boxes, wiring and terminations to equipment related to single point power service along with installing and terminating the externally mounted harmonic mitigating devices. Local motor disconnect shall be provided under Division 26 as required and/or indicated on plans where the VFD is located out-of-sight from the motor and the addition of a local motor disconnect does not introduce additional or increased hazards to persons or property.
11	Division 25 shall provide conduit, boxes, wiring, cabling, and terminations to equipment related to HVAC controls. Division 26 shall provide conduit, boxes, wiring and

MATRIX REMARKS	
	terminations to equipment related to power service and extension. Local safety disconnect shall be provided under Division 26 as required and/or indicated on plans.
12	For equipment other than packaged systems or those furnished with VFD's, Division 26 shall provide motor starters. Division 25 shall provide conduit, boxes, wiring, cabling, and terminations to equipment related to HVAC controls. Division 26 shall provide conduit, boxes, wiring and terminations to equipment related to power service and extension. Local safety disconnect shall be integral "combination type" with the starters.
13	Division 25 shall provide conduit, boxes, wiring, cabling, and terminations for communication cable intertie between central control equipment, control panels and control devices. Division 26 shall provide conduit, boxes, wiring and terminations to equipment for 120 volt power service.
14	Division 25 shall provide conduit, boxes, wiring, cabling, and terminations for communication cable intertie between central control equipment or control panels to lighting relay panels. Division 26 shall provide conduit, boxes, wiring and terminations to relay panels for 120 volt power service as well as for all line-voltage controlled lighting circuits routed through relays.
15	Division 26 shall furnish generator muffler for exhaust system. Division 23 shall install muffler and exhaust piping as required.
16	Division 22 shall provide fuel tank with alarm and level sensors and associated fuel piping and venting. Also, provided will be remote fill station, piping to fuel tank, and fill station alarm panels. Division 22 shall provide conduit, boxes, wiring, cabling, and terminations to equipment related to fill station controls and alarm. Division 26 shall provide conduit, boxes, wiring and terminations to equipment related to power service for fuel pumps and control panels. Division 26 shall also monitor fuel system status for annunciation through generator control panel.
17	Division 32 "Irrigation" shall provide conduit, boxes, wiring and terminations for low-voltage cabling between controller and valves. Division 26 shall provide conduit, boxes, wiring and terminations to controller related to power service.
18	Division 27 "Telecommunication" shall provide wiring and terminations for low-voltage communication cabling between equipment. Division 26 shall provide devices, wiring and terminations to equipment for 120 volt power service.
19	Division 28 "Security" shall provide wiring and terminations for low-voltage communication cable intertie between control panel, remote panels, and control devices. Division 26 shall provide wiring and terminations to equipment for 120 volt power service.
20	Division 28 "Security" shall provide wiring and terminations for low-voltage cabling between equipment. Division 26 shall provide devices, wiring and terminations to equipment for 120 volt power service.
21	Division 28 "Security" shall provide wiring and terminations for low-voltage cabling controls of equipment. Division 26 shall provide wiring and terminations to equipment for line-voltage power service.
22	Division 27 "Audio/Visual" shall provide audio and control devices to include their installation and termination of low-voltage cabling. Division 26 shall provide floor box, power receptacle and termination of line-voltage power service.
23	Division 27 "Audio/Visual" shall install speakers but shall turn speaker backbox over to Division 26 for installation.

END OF SECTION

Draft
(Not for Bidding)

SECTION 260060

POWER SYSTEM STUDY

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Services necessary to complete the system analysis studies required for the item specified under this Division, including but not limited to:
 - 1. Short circuit study.
 - 2. Protective device evaluation study.
 - 3. Protective device coordination study.
 - 4. Arc flash and shock risk assessment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with equipment specified elsewhere to perform a complete analysis study.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

- 1. American National Standards Institute, Inc. (ANSI):
 - ANSI Z535.4, Product Safety Signs and Labels
- 2. Institute of Electrical and Electronic Engineers (IEEE):

IEEE 242; Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE 399; Recommended Practice for Power System Analysis

IEEE 551; Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems

IEEE 1584; Guide for Performing Arc-Flash Hazard Calculations

- 3. National Fire Protection Association (NFPA):

NFPA 70 National Electric Code (NEC) with California Amendments

NFPA 70E; Standard for Electrical Safety in the Workplace

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. The results of the Power System Study shall be summarized in a final report. Three (3) bound copies of the final report shall be submitted.
 - 2. The report shall include the following Sections:
 - a. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system, which is included within the scope of the study.

- b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding it.
 - c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding it.
 - d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 - e. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays.
 - f. Confirmation in writing of compliance with Arc Energy Reduction per CEC Articles 240.67 and 240.87.
 - g. Confirmation in writing of compliance with all CEC mandated selective coordination requirements (e.g. CEC Articles 240.11, 517, 620, 645, 695, 700, 701, and 708) associated with this project. Include manufacturer selective coordination tables, etc. for documentation to be submitted to the Authority Having Jurisdiction (AHJ).
 - h. Tabulations of arc flash and shock risk assessment results and commentary regarding results.
 - i. Sample arc flash and shock hazard warning label.
3. Contractor shall also provide an electronic copy of the report as part of the Record Document process. Electronic copy of the report shall be in PDF format and its native file format (e.g. XXX.PRJ).
- B. The study shall be submitted prior to final review of the distribution equipment Shop Drawings, prior to release of equipment for manufacture. If formal completion of the study may cause delay in equipment manufacture, approval from the Architect may be obtained for a preliminary submittal of sufficient data to ensure that the selection of device ratings and characteristics will be satisfactory. Then the formal study will be provided to verify the preliminary findings.

1.04 QUALITY ASSURANCE

- A. The system analysis studies shall be performed by the Switchboard/Switchgear Manufacturer or by an approved Independent Testing Company. The analysis shall be stamped by a professional engineer licensed in the State of California.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 GENERAL

- A. The studies shall include all portions of the electrical distribution system from the main normal power services down to and including the 208 volt AC distribution system. Normal system connections and those that result in maximum fault conditions shall be adequately covered in the study.

3.02 SHORT CIRCUIT STUDY AND PROTECTIVE DEVICE EVALUATION STUDY

- A. The short circuit study shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.

- B. The study input data shall include the maximum available short circuit contribution, resistance and reactance components of the branch impedance, the X/R ratios, base quantities selected and other source impedance.
- C. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of maximum available current at each substation bus, switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include asymmetrical fault currents, symmetrical fault currents and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.
- D. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Architect's attention.

3.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, ground fault relays and low voltage breaker trip characteristics and settings. The studies shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. The coordination study shall include all medium and low-voltage classes of equipment from the building or plant service protective devices down to and including low voltage motor control centers and panelboards. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices
- C. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses, phase cable damage curves, ground cable damage curves, medium-voltage cable shield damage curves, ground resistor damage curves, etc. as appropriate for the project. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.
- D. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, Manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for

the medium voltage fuses where applied in the system. Any discrepancies, problem areas or inadequacies shall be promptly brought to the Architect's attention.

- E. In addition to the protective device coordination study settings, arc energy reduction settings shall also be tabulated. Consider all operating scenarios.
- F. The company performing the protective device coordination study shall provide completed and filled out circuit breaker settings labels. Label type (size, colors, text size, etc.) shall be approved by the Owner. Labels shall be similar to the following example with industrial grade self-adhesive backing, weatherproof, and UV proof. Labels shall be provided to the commissioning agent for the commissioning agent to install during commissioning.

CIRCUIT BREAKER SETTINGS			
T/U Mfr:		T/U Model:	
LTPU:		LTD:	
STPU:		STD:	
GFPD:		GFTD:	
INST:		Zone Intlk: (Y/N)	
Name:		Date:	
Verified By:		Date:	
Study Version:			

3.04 ARC FLASH AND SHOCK RISK ASSESSMENT

- A. An arc flash and shock risk assessment shall be performed in accordance with NFPA 70E (utilizing IEEE 1584 calculation method for incident energy analysis method) at each switchboard, distribution board, panelboard, etc. in accordance with the referenced standards. NFPA 70E hazard/ risk tables for arc flash PPE category method are not acceptable for compliance with this section.
- B. The arc flash and shock risk assessment shall include all voltage classes of equipment from the service entrance down to and including the panelboards, etc. in addition to all possible scenario configurations from alternate power sources (e.g. generators, etc.).
- C. The company performing the arc flash and shock risk assessment shall provide arc flash and shock hazard warning labels for all equipment evaluated in accordance with NFPA 70E and ANSI Z535.4. Labeling shall be as follows:
 - 1. Label type:
 - a. White vinyl or polyester with the following warning symbol color and black text:
 - 1) Incident energy below 40 cal/cm² = Orange.
 - 2) Incident energy for 40 cal/cm² and above = Red with DANGER symbol in lieu of WARNING.
 - b. Industrial grade self-adhesive backing.
 - c. Suitable for indoor or outdoor environments for a minimum of 3-years without fading or degrading.
 - 2. Label information (minimum):
 - a. Nominal system voltage.
 - b. Arc flash boundary (inches).

- c. Available incident energy and the corresponding working distance (inches).
 - d. Limited approach boundary (inches).
 - e. Restricted approach boundary (inches).
 - f. Equipment identification.
 - g. Date.
- 3. Labels shall be affixed to all equipment covered under the risk assessment by the company performing the arc flash and shock risk assessment.
 - 4. Prior to printing and affixing labels, coordinate with the Owner and Architect, which scenario will be used for the labels.

3.05 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

- A The equipment Manufacturer shall provide the services of a qualified field Engineer and necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Power System Study.

END OF SECTION 260060

SECTION 260526

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Power system grounding.
 - 2. Telecommunication system grounding.
 - 3. Electrical equipment and raceway grounding and bonding.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Building Steel.
 - 2. Division 22: Cold Water Piping.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):
UL 467; Grounding and Bonding Equipment.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
IEEE No. 142; Recommended Practice for Grounding of industrial and Commercial Power Systems.
IEEE No. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.03 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment as described herein and indicated on Drawings.
- B. Ground each separately derived system neutral as described herein and indicated on Drawings.
- C. Provide telecommunications system grounding conductor as described herein and indicate on Drawings.
- D. Except as otherwise indicated, the complete electrical installation including the neutral conductor, metallic conduits and raceways, cable trays, boxes, cabinets and equipment shall be completely and effectively grounded in accordance with all code requirements, whether or not such connections are specifically indicated or specified.
- E. Resistance:

1. Resistance from the main switchboard ground bus through the ground electrode to earth shall not exceed 5-OHMS unless otherwise noted.
2. Resistance from the farthest panelboard, switchboard, etc. ground bus through the ground electrode to earth shall not exceed 20-OHMS

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 3. Submit Manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Ground Rods:
 - a. Weaver.
 - b. Erico "Cadweld" Products, Inc.
 2. Ground Wells:
 - a. Christy Concrete Products, Inc.
 - b. Forni Corp.
 3. Ground Bushings, Connectors, Jumpers and Bus:
 - a. O-Z/Gedney.
 - b. Thomas & Betts Corp.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.02 GROUND CONDUCTORS

- A. Refer to Specification Section 260519: Building Wire and Cable for conductor specifications.
- B. General purpose insulated:
 1. UL approved and code sized copper conductor, with dual rated THHN/THWN insulation, color identified green.

2. Where continuous color-coded conductors are not commercially available, provide a minimum 4" long color band with green, non-aging, plastic tape in accordance with CEC.
- C. Bare conductors in direct contact with earth or encased in concrete: #4/0 AWG copper minimum, U.O.N.
- D. Bonding pigtails: Insulated copper conductor, identified green, sized per code, and provide with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.

2.03 DRIVEN (GROUND) RODS

- A. Copper clad steel, minimum 3/4-inch diameter by 8 feet long, unless otherwise noted.

2.04 GROUND WELL BOXES FOR GROUND RODS

- A. Precast concrete box nominal 9" throat diameter x 14" deep with light duty concrete cover for non-traffic areas or steel plate for traffic areas. Cover shall be embossed or engraved with "GROUND ROD".

2.05 INSULATED GROUNDING BUSHINGS

- A. Plated malleable iron or steel body with 150-degree Centigrade molded plastic insulating throat and lay-in grounding lug.

2.06 CONNECTIONS TO PIPE

- A. For cable to pipe: UL and CEC approved bolted connection.

2.07 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS OR SPLICES

- A. Where required by the Drawings, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds or high-pressure compression type connectors.
 1. Exothermic welds shall be used for cable-to-cable and cable-to-ground rod and for cable to structural steel surfaces. Exothermic weld kits shall be as manufactured by Cadweld or equal. Each particular type of weld shall use a kit unique to that type of weld.
 2. High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections.

2.08 EXTRA FLEXIBLE, FLAT BONDING JUMPERS

- A. Where required by Code, indicated on the Drawing, and specified herein.

2.09 BUILDING GROUND BUS REQUIREMENTS

- A. Main building power system ground bus:
 1. Provide one 24" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in main electrical room utilizing insulating stand-offs at 18" above finished floor.
 2. Furnish complete with cast copper alloy body lugs for connecting grounding system conductors. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer, and Belleville washer. Torque all lug connections.

3. All holes shall be drilled and tapped for single-hole lugs. Provide 6 spare lugs and lug spaces.
- B. Building power system reference ground bus:
1. The reference ground bus is furnished as part of the main electrical switchboard for the building, along with neutral disconnect and bus, and is in addition to the main building power system ground bus outlined above. The building grounding electrode shall make a direct connection to the building referenced ground bus in the main switchboard.
 2. Provide a #4/0 AWG copper ground conductor connection between the building reference ground bus in switchboard and the main building ground bus wall mounted in main electrical room.
- C. Telecommunication system ground bus requirements:
1. Main telecommunication system ground bus: Provide one 18" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in MDF room utilizing insulating stand-offs at 18" above finished floor.
 2. Telecommunication system ground bus: Provide one 12" wide x 4" high x 1/4" thick copper bus bar as a minimum. Mount on wall in each IDF room and in the MPOE room utilizing insulating stand-offs at 18" above finished floor.
 3. Furnish complete with cast copper alloy body lugs for connecting grounding system conductors. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer, and Belleville washer. Torque all lug connections.
 4. All holes shall be drilled and tapped for single-hole lugs. Provide 3 spare lugs and lug spaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of grounding system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 INSTALLATION

- A. Grounding electrodes:
1. Metal underground water pipe: Cold water metal piping system: Where the underground cold water service line is metal, in direct contact with the earth for 10-feet or more, the Contractor shall install a grounding electrode conductor from the main incoming cold water line ahead of the meter and extend to the main building reference ground bus in the main electrical room. The electrode shall be sized per CEC Article 250. Electrode connection should be accessible.
 2. Concrete encased grounding electrode (UFER ground): Provide a #4/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings which are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. The electrode shall extend through a horizontal length of 30 feet minimum and shall be encased in not less than 2 or more than 5 inches of concrete separating it

from surrounding soils. The electrode shall emerge from the concrete slab through a protective non-metallic sleeve and shall be extended to the main building reference ground bus.

END OF SECTION 260526

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(Not for Bidding)

SECTION 260529

ELECTRICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 03: Cast-in-place concrete. Concrete equipment pads.
 - 2. Division 05: Miscellaneous metals. Hangers for electrical equipment.
 - 3. Division 09: Ceiling suspension systems. Slack support wires.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):

UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.03 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of electrical equipment furnished and installed under Division 26.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
 2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
 - c. Thomas & Betts "Kindorf" Corp.
 3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.
 - c. Thomas & Betts "Kindorf" Corp.
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.02 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.03 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of ¼ inch to ½ inch diameter thread for rod support.

2.04 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.05 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch, 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1-1/2 inch on center in the base of the channel.

2.06 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
1. Use malleable strap with spacers for exterior and wet locations.

- 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod
- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.
- C. Where indicated on the Contract Documents, install freestanding electrical equipment on concrete pads.

3.03 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 26.
- B. Electrical device and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlet, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.
- J. Fabricate supports from 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.
- K. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.

- L. Bridge studs top and bottom with channels to support flush mounted cabinets and panelboards in stud walls.

3.04 ERECTION OF METAL SUPPORTS

- A. Cut, fit and place miscellaneous metal fabrications accurately in location, alignment and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.05 WOOD SUPPORTS

- A. Cut, fit, and place wood grounds, nailers, blocking and anchorage accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

3.06 ANCHORAGE

- A. All floor mounted, free standing electrical equipment such as transformers, switchboards, distribution boards, motor control centers, etc. shall be securely fastened to the floor structure.
- B. Anchorage of electrical equipment shall comply with the seismic requirements as outlined in Section 260010: Basic Electrical Requirements.

END OF SECTION 260529

SECTION 260531

CONDUIT

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
1. Rigid steel conduit and fittings.
 2. PVC insulated rigid steel conduit and fittings.
 3. Intermediate metal conduit and fittings.
 4. Electrical metallic tubing and fittings.
 5. Rigid non-metallic conduit and fittings.
 6. Flexible metallic conduit and fittings.
 7. Liquidtight flexible metallic conduit and fittings.
 8. Rigid aluminum conduit and fittings.
 9. Miscellaneous conduit fittings and products.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
1. Division 01: Cutting and patching.
 2. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.
 3. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 4. Division 07: Sheet metal flashing and trim.
 5. Division 09: Painting. Exposed conduit and other devices.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
1. American National Standards Institute, Inc. (ANSI):

ANSI C80.1;	Rigid Steel Conduit, Zinc-Coated.
ANSI C80.3;	Electrical Metallic Tubing, Zinc Coated.
ANSI C80.5;	Rigid Aluminum Conduit.
ANSI/ TIA-569-D	Telecommunications Pathways and Spaces.
 2. Underwriters Laboratories, Inc. (UL):

UL 1;	Flexible Metal Conduit.

UL 6;	Rigid Metal Conduit.
UL 360;	Liquid-Tight Flexible Steel Conduit.
UL 514B;	Conduit, Tubing and Cable Fittings.
UL 635;	Insulating Bushings.
UL 651; Fittings.	Schedule 40, 80, Type EB and A Rigid PVC Conduit and
UL 651A; Conduit.	Schedule 40 and 80 High Density Polyethylene (HDPE)
UL 797;	Electrical Metallic Tubing - Steel.
UL 1242;	Intermediate Metal Conduit - Steel.
3. National Electrical Manufacturer Association (NEMA):	
NEMA RN1;	PVC Externally coated Galvanized Rigid Steel Conduit.
NEMA TC 2;	Electrical Plastic Tubing and Conduit.
NEMA TC 3;	PVC Fittings for use with Rigid PVC Conduit.
NEMA TC 6;	PVC Plastic Utilities Duct (EB and DB Type)
NEMA TC 9;	Fittings for PVC Plastic Utilities Duct (EB and DB Type)

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 3. Submit Manufacturer's installation instruction. Provide written instructions for raceway products requiring glues, special tools, or specific installation techniques.

1.04 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted and approved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Metal conduit:
 - a. Allied Tube and Conduit Co.

- b. Triangle PWC, Inc.
 - c. Western Tube and Conduit Corp.
 - d. Spring City Electrical Manufacturing Co.
 - e. Occidental Coating Co. (OCAL).
 - f. Alflec Corp.
 - g. American Flexible Metal Conduit Co.
 - h. Anaconda.
2. Nonmetallic conduit:
- a. Prime Conduit.
 - b. JM Eagle.
 - c. Cantex.
3. Fittings:
- a. Appleton Electric Co.
 - b. OZ/Gedney.
 - c. Thomas & Betts Corp.
 - d. Spring City Electrical Manufacturing Co.
 - e. Occidental Coating Co. (OCAL).
 - f. Carlon.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.02 GALVANIZED RIGID STEEL CONDUIT (GRS)

- A. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and UL 6.
- B. Standard threaded couplings, locknuts, bushings, and elbows: Only materials of steel or malleable iron are acceptable. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.
- C. Three-piece couplings: Hot dip galvanized, cast malleable iron.
- D. Insulating bushings: Threaded polypropylene or thermosetting phenolic rated 150-degree C minimum.
- E. Insulated grounding bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
- F. Insulated metallic bushings: Threaded cast malleable iron body with plastic insulated throat rated 150-degrees C.
- G. All fittings and connectors shall be threaded.

2.03 PVC INSULATED GALVANIZED RIGID STEEL CONDUIT (PVC GRS)

- A. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 20 or 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.

- B. Fittings: Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

- A. Conduit: Hot dip galvanized steel meeting the requirements of CEC Article 342 and conforming to ANSI C80.6 and UL 1242.
- B. Fittings: Conduit couplings, connector and bushing shall be as specified for galvanized rigid steel conduit. Integral retractable type IMC couplings are also acceptable.

2.05 ELECTRICAL METALLIC TUBING (EMT)

- A. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.
- B. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2 inches. Setscrews shall be of case-hardened steel with hex-head and cup point to firmly seat in wall of conduit for positive grounding.
- C. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
- D. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
- E. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.

2.06 RIGID NON-METALLIC CONDUIT (PVC)

- A. Conduit:
 - 1. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 - 2. Rigid polyvinyl chloride, Type EB or DB conforming to NEMA TC 6 and UL 651, latest edition. UL listed for concrete encased burial and direct burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
- B. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.

2.07 FLEXIBLE METALLIC CONDUIT (FMC)

- A. Conduit: Shall be fabricated in continuous lengths from galvanized steel strip, spirally wound and formed to provide an interlocking design and conforming to UL 1.

- B. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Exception: Pressure cast screw-in connectors shall be acceptable for luminaire connection in suspended ceilings and cut-in outlet boxes within existing furred walls.

2.08 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

- A. Conduit: Shall be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquidtight jacket of polyvinyl chloride (PVC) and conforming to UL 360. Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.
- B. Fittings: Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push-in ferrule.

2.09 RIGID ALUMINUM CONDUIT (RAL)

- A. Conduit: Aluminum meeting the requirements of ANSI C80.5.
- B. Fittings: Conduit couplings, connectors, bushings, and elbows shall be aluminum.

2.10 RIGID NON-METALLIC CONDUIT (FRE)

- A. Conduit: Rigid fiberglass reinforced epoxy composed of glass filaments encapsulated in an epoxy matrix. Each conduit length shall have an integral wound in expanded couplings. Size 2" through 6" shall incorporate an integral urethane gasket for sealing. No threads or adhesive shall be required to assemble the joints for in ground installations. All conduit and fittings will be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for U.V. protection.
- B. Conduit and fittings shall be filament wound.
- C. Conduit shall be suitable for continuous operation from -40°C to +110°C without significant change of mechanical properties. Conduit combustion by-products shall not contain chlorine gas in excess of trace levels and always less than OSHA limits.
- D. FRE conduit shall be designated so conductors shall not adhere to conduit or fittings in fault conditions.
- E. Dimensions: Conduit and fittings in 2" through 6" sizes inclusive shall have inside diameter equal to the trade size.

2.11 MISCELLANEOUS CONDUIT FITTINGS AND PRODUCTS

- A. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
- B. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
- C. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4"

conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.

- D. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.
- E. Fire rated penetration seals:
 - 1. UL building materials directory classified.
 - 2. Conduit penetrations in fire rated separation shall be sealed with a UL classified fill, void or cavity material.
 - 3. The fire rated sealant material shall be the product best suited for each type of penetration and may be a caulk, putty, composite sheet, or wrap/strip.
- F. Standard products not herein specified:
 - 1. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - 2. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.
 - 3. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of conduit system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 APPLICATION

- A. Galvanized rigid steel conduit (GRS) can be used in the following applications:
 - 1. For feeders and branch circuits located indoors, concealed or exposed above suspended ceilings, in damp/wet locations, in crawl spaces, in attics, chases, furred spaces, equipment rooms, loading docks or in hazardous locations in accordance with CEC and local Codes.
 - 2. For feeders and branch circuits concealed in concrete floors and walls when not in contact with earth.
- B. PVC insulated galvanized rigid steel conduit can be used in the following applications:
 - 1. Use 40-mil coating for feeders and branch circuits in damp or wet locations.
 - 2. Use 20- or 40-mil for feeders and branch circuits concealed in concrete walls or slabs in contact with earth.

3. Use 20- or 40-mil for runs beneath floor slabs on grade.
 4. Use 40-mil for all below grade penetrations through floor slabs on grade or exterior walls.
- C. Intermediate metal conduit (IMC): Can be used for the same application as galvanized rigid steel conduit as specified herein.
- D. Electrical metallic tubing (EMT): Can be used exposed or concealed for interior electrical feeders 4" and smaller, interior power and lighting branch circuits and low tension distribution system where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within electrical, communication or signal rooms or closets.
- E. Rigid non-metallic conduit (PVC): Can be used in the following applications:
1. Schedule 40 or 80 for feeders and branch circuits run beneath ground floor slab except that bends and penetrations through the floor must be PVC coated galvanized rigid steel.
 2. Schedule 40 or 80 for exterior branch circuits directly buried in earth, 18" minimum below grade. PVC may be used below exterior slabs not subject to vehicular traffic.
 3. PVC may be used below exterior slab subjects to vehicular traffic when encased in a minimum of 2 inches of concrete.
 4. Only schedule 80 PVC may be used for above ground conduit extensions on utility poles.
 5. PVC elbows shall be radius sweep type schedule 40 for bends 45° or less and large radius sweep type schedule 80 for bends 46° or greater.
 6. In general, PVC may not be run exposed in concrete walls or in floor slabs unless expressly indicated on the Drawings.
 7. EB or DB type may be installed in lieu of the above only if encased in a minimum of 2 inches of concrete.
 8. Serving utility electrical and telephone and cable television service entrance conduits may be EB or DB type conduit only if acceptable by serving utility. Coordinate in field prior to installation.
- F. Flexible metallic conduit (FMC): Can be used only in dry locations for connections from an adjacent outlet box or conduit to all motors, transformers, vibrating equipment or machinery, controllers, solenoid valves, float and flow switches or similar devices and to luminaires installed in suspended ceilings, minimum sizes shall be 3/8" for luminaires and control wiring and 1/2" for motor and transformer connections. U.O.N.
- G. Liquidtight flexible metallic conduit (LFMC): Can be used in wet or damp locations for connections from adjacent outlet box or conduit to all motors, transformers, vibrating equipment or machinery, controllers, solenoid valves, float and flow switches or similar devices. These areas are typically food preparation and dishwashing areas, sump wells, loading docks, pump rooms, exterior areas, etc. Minimum sizes shall be 1/2" and 1" for communications.

- H. Rigid aluminum conduit (RAL): Can be used for feeders and branch circuits operating above 360 Hz. or where indicated on Contract Drawings or by these Specifications.
- I. Rigid non-metallic conduit (FRE): Can be used for direct burial, concrete encasement and for bridge applications whether suspended or encased; except in hazardous location, where indicated on Contract Drawings or by these Specification.
- J. Fire-Resistive Cable Systems: Refer to CEC Article 728. All devices utilized, mountings, and supports shall be listed as part of the fire-resistive system.

3.03 PREPARATION

- A. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
- B. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
- C. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
- D. Conduits shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
- E. Communications conduits shall not be placed closer than 12 inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
- F. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
- G. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
- H. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.
- I. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.
- J. Connect recessed luminaires to conduit runs with maximum six feet of flexible metal conduit or MC cable extending from a junction box to the luminaire or manufactured wiring system.

3.04 INSTALLATION

- A. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Minimum Conduit Size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1/2" for interior applications and 3/4" for exterior and underground applications.
- C. Minimum Communication and Signal Conduit Size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1" for interior applications and 2" for exterior and underground applications.
- D. All conduit sizes indicated on the Drawings are sized for copper conductors with THHN/THWN insulation. If conductor type or size is changed the Contractor shall be responsible for resizing conduits upward to meet Code.
- E. All communication and signal conduit sizes indicated on the Drawings are sized for 40% fill or less for category 6 or 6A cable. If cable type or size is changed the Contractor shall be responsible for resizing conduits upward to meet a maximum 40% fill.
- F. In general, all conduit work shall be concealed where possible. Exceptions shall be electrical, communication and mechanical rooms, exposed ceiling areas, and parking garages.
- G. Conduit connections to motors and surface cabinets shall be concealed, except for electrical, communication and mechanical rooms, or unless exposed Work is clearly called for on the Drawings.
- H. Install conduits in complete runs before pulling in cables or wires.
- I. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
- J. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
- K. In making joints in rigid steel conduit, ream conduit smooth after cutting and threading. Coat all field-threaded joints with UL approved conductive type compound to ensure low resistance ground continuity through conduit and to prevent seizing and corrosion.
- L. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
- M. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
- N. Conduit systems shall be mechanically and electrically continuous throughout. Install code size, insulated, copper, green-grounding conductors in all conduit runs for branch circuits and feeders. This conductor is not indicated on the Drawings. Refer to Section 260526: Grounding and Bonding.
- O. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).

- P. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
- Q. A run of conduit between terminations at wire pulling points shall not contain more than the equivalent of four quarter bends (360-degrees, total).
- R. A run of communications and signal conduit between terminations at wire pulling points shall not contain more than the equivalent of two quarter bends (180-degrees, total).
- S. Emergency power raceway system: Install entirely independent of other raceway systems, except where specifically allowed by CEC Article 517.

3.05 PENETRATIONS

- A. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - 1. Where indicated on the Structural Drawings.
 - 2. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
- B. Cutting or holes:
 - 1. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - 2. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - 3. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - 4. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.
- C. Sealing:
 - 1. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - 2. Fire stop: Where conduits, wireways and other electrical raceways pass through fire rated partitions, walls, smoke partitions or floor; install a UL classified fire stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire stop material.
- D. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.

1. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be PVC coated rigid galvanized steel.
2. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.
3. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
4. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.06 CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to PVC coated rigid steel conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- G. Do not install aluminum conduit embedded in or in contact with concrete.
- H. Provide schedule 40 non-metallic sleeve through concrete or masonry walls where aluminum conduit penetrations are required.

3.07 UNDERGROUND INSTALLATION

- A. Perform trenching, backfilling and compaction operations as specified in Division 31: Trenching.
- B. Install service utility company underground conduits in strict conformance to each utility company's requirements. Obtain a copy of each utility company's installation guidelines prior to commencing Work.
- C. Tops of conduits shall be as follows unless otherwise noted:
- D. Not less than 18-inches below finished grade.
- E. Not less than 24-inches below roadways, paved parking lots, driveways or any surface subject to vehicular traffic.
- F. Not less than 4 inches below building floor slab for branch circuits. Major feeders and large signal conduits (2" and greater) at not less than 18-inches.
- G. Depth of service utility conduits shall conform to utility company requirements.

- H. Furnish and install specified underground conduit marker 12" above conduits in trenches with all buried conduits.

3.08 TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Conduits shall be securely fastened to cabinets, boxes and gutters using two locknuts and an insulating bushing or specified insulated connectors. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Install grounding bushings or bonding jumpers on all conduits terminating at concentric or eccentric knockouts.
- D. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using specified connectors and hubs.
- E. Stub-up connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver operated threaded flush plugs with floor.
- F. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating in switchgear, cabinets, or gutters inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- G. Raceway seal: Inject into wire filled raceways, a pre-formulated rigid 2 lbs. density polyurethane foam which expands a minimum 35 times its original bulk. Foam shall have the physical properties of water vapor transmission of 1.2 to 3.0 perms: water absorption less than 2% by volume, fungus and bacterial resistant. Foam shall permanent seal against water, moisture, insects, and rodents. Install raceway sealing foam at the following points:
 - 1. Where conduits pass from warm locations to cold locations to prevent passage of water vapor (such as refrigerated spaces, constant temperature rooms, air-conditioned spaces, etc.).
 - 2. Where conduits enter buildings from below grade.
 - 3. Where conduits enter or leave animal rooms or research labs.
- H. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
 - 1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.

2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15 inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.
- I. Use short length (maximum of 6ft) of the appropriate FMC or LFMC conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquidtight flexible metal conduit for installation in exterior locations, moisture or humidity-laden atmosphere, corrosive atmosphere, water hose or spray wash-down operations and locations subject to seepage or dripping of oil, grease, or water. Provide a green ground wire with FMC or LFMC conduit.

3.09 SUPPORTS

- A. Provide supports for raceways as specified in Section 260529: Electrical Hangers and Supports.
- B. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
- C. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
- D. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.
- E. Individual 1/2" and 3/4" conduits installed above suspended ceilings may be attached to dedicated hanger wires using spring steel support clips provided that not more than two conduits are attached to any single support wire. Do not attach to ceiling hanger wires.
- F. Support exposed vertical conduit runs at each floor level, independent of cabinets or switches to which they run, by means of acceptable supports.
- G. Fasteners and supports in solid masonry and concrete:
 1. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 2. After concrete installation:
 - a. Steel expansion anchors not less than 1/4 inch bolt size and not less than 1-1/8" embedment.
 - b. Power set fasteners not less than 1/4 inch diameter with depth of penetration not less than three inches.
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- H. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.

- I. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

END OF SECTION

Draft
(Not for Bidding)

SECTION 260533

BOXES

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Wall and ceiling outlet boxes.
 - 2. Pull and junction boxes.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 08: Access doors. Wall and ceiling access doors.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified.
 - 1. American National Standards Institute/National Electrical Manufacturer Association:

ANSI/NEMA OS-1; Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

ANSI/NEMA OS-2; Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

NEMA 250; Enclosures for Electrical Equipment (1000 volts maximum).

- 2. Underwriters Laboratories (UL):

UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.

UL 514A; Metallic Outlet Boxes.

UL 1773; Termination Boxes.

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Outlet and junction boxes:
 - a. Spring City Electrical Manufacturing Co.
 - b. Thomas & Betts Corp.
 - c. Racor, Inc.
 - 2. Cast boxes:
 - a. Appleton Electric Co.
 - b. Crouse-Hinds.
 - 3. Floor boxes:
 - a. Hubbell Inc.
 - b. Walker.
 - c. Raceway Components, Inc.
 - 4. Pullboxes:
 - a. Circle AW Products.
 - b. Hoffman Engineering Co.
 - 5. Precast concrete boxes:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
 - 6. Sound and fire-rated putty pads:
 - a. QuietPutty
 - b. Hilti
 - c. Or Equal
- B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.02 OUTLET BOXES

- A. Standard outlet box:
 - 1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
 - 2. 4-inch square by 1.5-inch deep shall be minimum box size.

3. ANSI/NEMA OS 1.
- B. Concrete box:
 1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.
 2. Select height as necessary to position knockouts above concrete reinforcing steel.
 3. ANSI/NEMA OS 1.
- C. Tile box:
 1. Provide outlet boxes for installation in tile or concrete block walls.
 2. Standard outlet boxes with raised, square corners and device covers are acceptable.
 3. ANSI/NEMA OS 1.
- D. Cast metal outlet body:
 1. Provide 4-inch round, galvanized cast iron alloy with threaded hubs and mounting lugs as required.
 2. Provide boxes with cast cover plates of the same material as the box and neoprene cover gaskets.
- E. Conduit outlet body: Provide Cadmium plated cast iron alloy, oblong conduit outlet bodies with threaded conduit hubs and neoprene gasket, cast iron covers.

2.03 PULL AND JUNCTION BOXES

- A. Sheet metal pull and junction box:
 1. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 2. ANSI/NEMA OS 1.
- B. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
- C. Flush mounted pull boxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.
- D. Precast concrete boxes: Provide high density reinforced concrete pull and junction box with end and side knockouts and non-settling shoulders. Use cast iron lid with hold down bolts or use traffic rated covers in areas subject to vehicular traffic.

2.04 FLOOR BOXES

- A. Refer to Section 262726: Wiring Devices for floor mounted service boxes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of box installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 PREPARATION

- A. Install all outlet boxes flush with building walls, ceilings, and floors except where boxes are installed in mechanical and electrical rooms, in cabinetry, above accessible ceilings or where exposed Work is called for on the Drawings.
- B. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
- C. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.
- D. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.
- E. Locate outlet boxes above hung ceilings having concealed suspension systems, adjacent to openings for removable recessed luminaires.
- F. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
- G. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.

3.03 INSTALLATION

- A. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Locate electrical boxes as indicated on Drawings and as required for splices, taps, wire pulling, equipment connections and Code compliance.
- C. Install junction or pullboxes where required to limit bends in conduit runs to not more than 360 degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
- D. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
- E. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
- F. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
- G. Welded outlet boxes shall only be used in concealed interior installations.
- H. Provide precast concrete boxes in exterior planting areas, walkways, roads etc.
- I. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.
- J. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

- K. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.
- L. Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.
- M. Add additional sheet rock as necessary to maintain original fire rating of walls where boxes are installed.
- N. Install galvanized steel coverplates on boxes in unfinished areas, above accessible ceilings and on surface mounted outlets.

3.04 SUPPORTS

- A. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
- B. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
- C. Support boxes independently of conduit system.
- D. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
- E. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

END OF SECTION 260533

SECTION 270010

BASIC COMMUNICATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Table of Contents, Division 27 - Communications:

<u>SECTION NO.</u>	<u>SECTION TITLE</u>
270010	BASIC COMMUNICATION REQUIREMENTS
270528	COMMUNICATION PATHWAYS
270529	COMMUNICATION HANGERS AND SUPPORTS
270553	COMMUNICATION IDENTIFICATION
271100	COMMUNICATION EQUIPMENT ROOMS
271313	COMMUNICATION BACKBONE COPPER CABLING
271323	COMMUNICATION BACKBONE FIBER OPTIC CABLING
271500	COMMUNICATION HORIZONTAL CABLING

B. Work included: This Section includes general administrative and procedural requirements for Division 27. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Rough-in.
8. Communication installation.
9. Cutting, patching, painting, and sealing.
10. Field quality control.
11. Cleaning.
12. Project closeout.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 27 Sections.
2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, etc. Refer to Division 31, Earthwork.

3. Concrete Work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, pullbox slabs, vaults, etc. Refer to Division 03, Concrete.
 4. Miscellaneous metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, cable trays, racks, etc. Refer to Division 05, Miscellaneous Metals.
 5. Miscellaneous lumber and framing Work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of communications materials and equipment. Refer to Division 06, Rough Carpentry.
 6. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vaportight. Refer to Division 07, Thermal and Moisture Protection.
 7. Access panels and doors: Required in walls, ceilings, and floors to provide access to communications devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 8. Painting: Include surface preparation, priming and finish coating as required for exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
 9. Conduit: Include conduit and boxes for Interbuilding and Intra-building distribution of cabling. Refer to Division 26: Sections 260531, 260533, and 260543.
- D. Work furnished and installed under another Division requiring connections under this Division includes but is not limited to:
1. Fire alarm control panel.
 2. Elevator controllers
 3. Lighting control panels.
 4. Mechanical BAS control panel
 5. Security alarm control panel(s)

1.02 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.
- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

1. California Electrical Code (CEC).
 2. California Building Code (CBC).
 3. California Fire Code (CFC).
 4. California Mechanical Code (CMC).
- D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
BICSI	Building Industry Consulting Service International, Inc
EIA	Electronics Industries Alliance
FCC	Federal Communications Commission
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
TIA	Telecommunication Industry Association
UL	Underwriters' Laboratories

1.03 DEFINITIONS

- A. The following list of terms as used in the Division 27 documents shall be defined as follows:
1. Adapter: Shall mean a connecting device joining two fiber connectors, either like or unlike.
 2. Administration: The methodology defining the documentation requirements of a cabling system and its containment, the labeling of functional elements and the process by which moves, additions, and changes are recorded.
 3. Attenuation: The decrease in magnitude of transmission signal strength between points, expressed in dB as the ratio of output to input signal level.
 4. Attenuation-to-crosstalk ratio (ACR): The ratio obtained by subtracting insertion loss (attenuation dB) from near-end crosstalk (dB). ACR is normally stated at a given frequency.
 5. Auditory assistance device: An intentional radiator used to provide auditory assistance to a handicapped person or persons. Such a device may be used for auricular training in an educational institution, for auditory assistance at places of public gatherings, such as a church, theater, or auditorium, and for auditory assistance to handicapped individuals, only, in other locations.
 6. Backboard: Backboard generally refers to the 3/4" A-C grade plywood sheeting, lining the walls of the telecommunications room, with the "A" side facing into the room. Plywood shall be void-free with two coats of fire-retardant paint matching the painted interior walls covering both sides.
 7. Backbone: A facility (e.g., pathway, cable, or conductors) between any of the following spaces: telecommunications rooms, common telecommunications rooms, floor-serving terminals, entrance facilities, equipment rooms, and common equipment rooms.

8. Basic link test configuration: Horizontal cable of up to 295 feet plus up to 6.5 feet of test equipment cord from the main unit of the tester to the local connection, and up to 6.5 feet of test equipment cord from the remote connection to the remote unit of the tester. Maximum length is 308 feet.
9. Bonding Conductor (BC): A conductor used specifically for the purpose of bonding.
10. Cable Labeling System:
 - a. The scheme employed when identifying cable or its associated hardware.
 - b. Scheme adapted for labeling cables to identify them based on ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure.
11. Cable Runway: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wiring inside the MC, IC, or TR rooms.
12. Cabling: A system comprised of cables, wires, cords, and connecting hardware.
13. Ceiling Distribution System: A distribution system that utilizes the space between a suspended or false ceiling and the structural surface above.
14. Channel: End-to-end transmission path, i.e. the entire portion of the horizontal cabling to each outlet consisting of the Permanent Link, line cord (at the workstation), patch cord, and, if a full cross-connection is implemented, the cross-connect termination/connecting apparatus and equipment cord.
15. Connect: To install required patch cords, equipment cords, cross-connect wires, etc. to complete an electrical or optical circuit.
16. Cord: Shall mean length of cordage having connectors at each end. The term "cord" is synonymous with the term "jumper" and "lead."
17. Entrance Conduit: Conduit that connects the campus underground infrastructure with the building's Telecommunications Room.
18. Fire Retardant: Any substance added to delay the start or ignition of fire or slow the spread of the flame of any material.
19. Firestopping: The process of installing (specialty) listed fire-rated materials into penetrations of fire-rated barriers to reestablish the fire-resistance rating of the barrier.
20. Firestopping Location: A penetration through a fire-rated wall with a sleeve.
21. Firestop System: A specific installation consisting of the material(s) (firestop penetration seals) that fill the opening in the wall or floor assembly, and around and between any items that penetrate the wall or floor (e.g., cables, cable trays, conduit, ducts, pipes), and any termination devices (e.g., electrical outlet boxes) along with their means of support.
22. Horizontal Cabling: The part of the cabling system that extends from the work area telecommunications outlet to the horizontal cross-connect in the telecommunications room.
23. Hybrid Cable: An assembly of two or more cables, of the same or different types or categories, covered by one overall sheath.

24. Identifier: A unique code assigned to an element of the communication infrastructure that links it to its corresponding record.
 25. Infrastructure (Telecommunications): A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of all information within a building or campus.
 26. Loose Tube: A type of optical fiber cable construction where one or more fibers are laid loosely in a tube. Also called loose tube fiber.
 27. Passive link segment: Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.
 28. Permanent link: Test configuration for a horizontal cabling link excluding test cords, connections at the ends of the test cords, patch cords, equipment cords, line cords, etc. The "permanent" portion of the horizontal cabling to each outlet consisting of cable, consolidation point (if used), termination/connecting apparatus in equipment rooms, and the connectors at outlets.
 29. Telecommunications Entrance Facility: Utility Partnerships/Alternate Carrier Minimum Point of Entry that is usually located within the Main Cross-connect Room (MC).
- B. Abbreviations:
1. AFF: Above Finish Floor. Standard mounting height (e.g. 18" AFF) for a device using the center line of the device as the measurement point.
 2. BEP: Building Entrance Protection. For termination of OSP twisted pair cabling.
 3. CAT: Category. Used when identifying the performance characteristics of twisted pair cabling.
 4. CMP: Communication Media Plenum. Rating applied to ISP twisted pair cable. Cable shall be listed as being suitable for use in ducts, plenums, and other spaces used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics. Cables must pass required test for fire and smoke characteristics of wires and cables, NFPA 262 or UL 910.
 5. CMR: Communication Media Riser. Rating applied to ISP twisted pair cable. Cable shall be listed as being suitable for use in a vertical run in a shaft or from floor-to-floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor. Cables must pass requirements for flame propagation.
 6. CCTV: Closed-Circuit Television. A private television system, typically used for security purposes, in which the signal is transmitted to a limited number of receivers.
 7. EMI: Electromagnetic Interference. Radiated or conducted electromagnetic energy that has an undesirable effect on electronic equipment or signal transmissions.
 8. IC: Intermediate Cross-Connect. The cross-connect points between a backbone cable that extends from the main cross-connect and the backbone cable from the horizontal cross-connect.

9. IDF: Intermediate Distribution Facilities. Telecommunication equipment rooms housing network equipment and containing termination fields for backbone cabling from MDF and horizontal cabling from outlet devices.
10. IR: Intermediate Cross-Connect Room. Telecommunication equipment rooms housing network equipment and containing termination fields for backbone cabling from MDF and horizontal cabling from outlet devices.
11. ISP: Inside Plant. Cable installation within building.
12. MAN: Metropolitan Area Network. A data communications network that covers an area larger than a campus area and smaller than a wide area network. Typically interconnects two or more LANs and usually covers an entire metropolitan area.
13. MC: Main Cross-Connect. The cross-connect normally located in the MDF room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables.
14. MDF: Main Distribution Facilities. Telecommunication equipment room housing possible service entrance facilities for interbuilding backbone cabling, network equipment, house voice system equipment headend, backbone cabling distribution headend, termination fields for backbone and horizontal cabling.
15. MMF: Multimode Fiber Cable. An optical fiber that carries many paths of light or an optical waveguide that allows many bound modes to propagate.
16. MPOE: Minimum Point of Entry. For serving communications utility terminations. House's service provider's termination field(s) and interfaces between utility's facilities and premises facilities.
17. NIC – Network Interface Card. Lookup BICSI def.
18. OFN: Optical Fiber Non-Conductive. General purpose indoor non-plenum rated.
19. OFNP: Optical Fiber Non-Conductive Plenum. Plenum rated cable.
20. OFNR: Optical Fiber Non-Conductive Riser. Non-plenum rated riser cable.
21. OSP: Outside Plant. Cable installation outside of building.
22. PIC: Plastic Insulated Conductors.
23. PVC: Polyvinyl Chloride.
24. SMF: Singlemode Fiber Cable. An optical fiber, usually step-index grade, which supports only one mode of light propagation. This does not necessarily imply single wavelength operation. The light source is normally a laser.
25. STR: Strand. A single unit of optical fiber within a cable (e.g., a 12-strand fiber cable has 12 individual optical fibers within the cable sheath).
26. TMGB: Telecommunications Main Grounding Busbar. A grounding busbar, located in the MDF room, connected to the power system main building ground bus by a continuous #1/0 THHN wire.
27. TGB: Telecommunication Grounding Busbar. A grounding busbar, located in the IDF and MPOE rooms, connected to the telecommunication main ground bus at ground or second floor, and as a riser to all stacked IDF rooms by a continuous #1/0 THHN wire.

28. TER: Telecommunications Equipment Room. A centralized space that provides space and maintains a suitable operating environment for the termination of backbone and campus cabling and house centralized communications and/ or computer equipment (such as Core Switches and Servers). Note: An equipment room is considered distinct from a telecommunications closet because of the nature or complexity of the equipment housed by the equipment room.
29. TR: Telecommunications Room. A room dedicated to housing a group of telecommunications connectors (e.g., patch panel or punch-down block) that allows equipment and backbone cabling to be cross connected with patchcords or jumpers.
30. UTP: Unshielded Twisted Pair. Copper cable type.

1.04 SUBMITTALS

- A. Format: Furnish submittal data in electronic (.pdf) format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B. Source and Quality: Submittals shall be generated directly from the manufacturer's electronic documentation and shall maintain full text searchability. Scanned, photocopied, or otherwise non-searchable documents will not be accepted.
- C. Legibility: All submitted documents shall be of high resolution, clearly legible, and free from distortions, artifacts, or other quality deficiencies that could impair readability.
- D. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- E. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.
- F. The Contractor shall submit detailed Drawings of all communications equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of communications equipment indicated on the Drawings shall match those of the communications equipment that is being submitted for review, i.e.: equipment racks, cable ladder, fuse protectors, ground bars, etc. Minimum scale: 1/4" = 1'- 0". Revised communications equipment layouts must be approved prior to release of order for equipment and prior to installation.
- G. As part of the equipment submittals, the Contractor shall provide anchorage calculations for floor and wall mounted communication equipment, conduits, and

raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

- H. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
- I. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
- J. All re-submittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Re-submittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.
- K. Substitutions:
 - 1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.
 - 2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
 - 3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility and appearance will be approved as substitutions to that specified.
 - 4. Whenever any material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
 - 5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
 - 6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the

substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.05 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the communications Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Preparation:

1. Drawings:
 - a. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
 - b. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.

1.06 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of telecom outlets, patch panels, termination blocks, security panels, security devices, fiber panels, fire alarm panels, intercom systems, clock system, video system, labeling of all components and systems, correct conduit and cabling as well as routing, revised fire alarm schedule listing Manufacturers and products actually installed. Contractor shall record all changes in the Work during the course of construction on black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not, current monthly payments may be withheld.
2. Record Drawings shall be the transfer of information on these prints to the construction documents via building information modeling (Revit) process. A set of Revit files of the communication construction documents will be provided to the Contractor by the Engineer. For the BIM/clash detection process, a Revit file of the communication construction documents will be provided to the Contractor by the Engineer, which will represent a LOD of 300 design level.
3. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. All underground installation.
 - b. Building communications rough-in.
 - c. Final communications installation.
4. All record drawings shall include measurements from two permanent landmarks or cornerstones. Measurements for underground equipment or pathways shall include depth.
5. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. One electronic file of Revit
 - b. One electronic set in pdf.

1.07 OPERATION AND MAINTENANCE MANUALS

- A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 27. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 ROUGH-IN

- A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- B. Verify final locations for rough-in with field measurements and with the requirements for the actual equipment to be connected.

3.02 COMMUNICATIONS INSTALLATION

- A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Comply with the following requirements:
 - 1. Shop Drawings prepared by Manufacturer.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for communications installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate and integrate installations of communications materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
 - 7. Coordinate connection of communications systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 9. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 10. Install communications equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 - 11. Coordinate communications systems, equipment, and materials installations with other building components.

12. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
13. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.
14. Conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.

3.03 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- E. Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.
- F. Application of joint sealers:
 1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around communications services penetrating floors and walls, to provide fire-stops and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.04 FIELD QUALITY CONTROL

- A. General testing requirements:
 1. The purpose of testing is to ensure that all tested communications equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
 2. Tests and inspections shall determine suitability for energization.
 3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.
 4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.
- B. Tests: In addition to specific system test described elsewhere, tests shall include:

1. Equipment operations: Test All systems for proper operation
 2. Circuit numbering verification: Select on a random basis various patch panel ports and wire test to verify compliance of the port labeling with actual field wiring.
- C. Contractor shall perform testing on fiber strands with an OTDR and Power Meter.
- D. Contractor shall perform testing on each cable of the Structured Cabling system with test equipment that will provide a full test of the EIA/TIA requirements for the installed category cable and provide test results of each cable under test.
- E. Testing safety and precautions:
1. Safety practices shall include the following requirements:
 - a. Applicable State and Local safety operating procedures.
 - b. OSHA.
 - c. NSC.
 - d. NFPA 70E.
- F. Calibration of test equipment:
1. Testing Agency shall have calibration program that assures test instruments are maintained within rated accuracy.
 2. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6-month maximum; Digital, 12-months maximum.
 - b. Laboratory instruments: 12-months.
 - c. Leased specialty equipment: 12-months where accuracy is guaranteed by lessor.
 3. Dated calibration labels shall be visible on test equipment.
 4. Records, which show date and results of instruments calibrated or tested, must be kept up to date, and shall be provided at Owner's request.
 5. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
 6. Calibration standards shall be of higher accuracy than instrument tested.
 7. Equipment used for field testing shall be more accurate than instrument being tested.
- G. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- H. Notify Owner and Engineer one week in advance of any testing.
- I. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.

- J. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- K. Include all test results in the maintenance manuals.

3.05 CLEANING

- A. Prior to acceptance of communications systems, the Contractor shall thoroughly clean communications rooms from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all communications equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.06 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than 2-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 2-hours training is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.
- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION 270010

SECTION 270528

COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit and fittings.
 - 2. Fire-rated wall and floor through-penetration.
 - 3. Boxes
 - 4. Vaults
 - 5. J-Hooks.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01: Cutting and patching.
 - 2. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 - 3. Division 07: Sheet metal flashing and trim.
 - 4. Division 08: Access doors. Wall and ceiling access doors.
 - 5. Division 09: Painting. Exposed conduit and other devices.
 - 6. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI)/National Electrical Manufacturer Association (NECA):

ANSI C80.3;	Electrical Metallic Tubing, Zinc Coated.
ANSI/NEMA OS-1; Supports.	Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box
NEMA 250;	Enclosures for Electrical Equipment (1000 volts maximum).
2. American Society for Testing and Materials (ASTM):	
ASTM E84;	Surface Burning Characteristics of Building Materials
ASTM E119;	Fire Tests of Building Construction and Materials
ASTM E814;	Fire Tests of Penetration Fire Stops

ASTM E1725; Standard Test Methods for Fire Tests of Fire Resistive Barrier Systems for Electrical System Components

3. Underwriters Laboratories, Inc. (UL):

UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.

UL 263; Fire Tests of Building Construction and Materials

UL 514A; Metallic Outlet Boxes.

UL 514B; Conduit, Tubing and Cable Fittings.

UL 635; Insulating Bushings.

UL 651; Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

UL 651A; Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.

UL 723; Surface Burning Characteristics of Building Materials

UL 797; Electrical Metallic Tubing - Steel.

UL 1479; Fire Tests of Through Penetration Firestops

UL 1773; Termination Boxes.

UL 2239; Hardware for the Support of Conduit, Tubing, and Cable

4. National Electrical Manufacturer Association (NEMA):

NEMA TC 2; Electrical Plastic Tubing and Conduit.

NEMA TC 3; PVC Fittings for use with Rigid PVC Conduit.

NEMA TC 6; PVC Plastic Utilities Duct (EB and DB Type)

NEMA TC 9; Fittings for PVC Plastic Utilities Duct (EB and DB Type)

1.03 SYSTEM DESCRIPTION

- A. Conduits supported from structure and within stud walls for the continuous routing of communication cables, where non-accessible concealed Work is indicated and where required by Code and/or shown on the Drawings. Conduits shall be sized for a 40-percent maximum cable fill ratio.
- B. Assemblies supported from structure for the continuous routing of communication cables, where exposed Work is indicated on the Drawings.
- C. J-Hooks supported from structure, above suspended ceiling, for the routing of communication cables, where accessible through ceiling and where shown on the Drawings. J-hooks shall be sized for a 40-percent maximum cable fill ratio.
- D. Where exposed cable routing is indicated, provide conduit sleeves through walls, above suspended ceilings or at cable routing elevation, with insulated bushings on both ends, for access into enclosed spaces, i.e., offices, workrooms, conference rooms, etc. Sleeves shall be 2" minimum and 4" maximum conduits and shall be sized for a 40-percent maximum cable fill ratio.

- E. Provide UL listed fire-rated sleeves for passing through rated walls and/or floors assemblies.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete Bill of Material listing all components.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Conduit:
 - a. Metal conduit:
 - 1) Allied Tube and Conduit Co.
 - 2) Triangle PWC, Inc.
 - 3) Western Tube and Conduit Corp.
 - b. Nonmetallic conduit:
 - 1) Prime Conduit.
 - 2) JM Eagle.
 - 3) Cantex.
 - c. Fittings:
 - 1) Appleton Electric Co.
 - 2) OZ/Gedney.

- 3) Thomas & Betts Corp.
 - 4) Carlon.
 - 2. Fire-rated penetration assemblies:
 - a. EZ-Path, STI Firestop.
 - b. Hilti
 - c. 3M
 - d. Lowry's, Inc.
 - 3. Boxes:
 - a. Outlet and junction boxes:
 - 1) Spring City Electrical Manufacturing Co.
 - 2) Thomas & Betts Corp.
 - 3) Raco, Inc.
 - b. Cast boxes:
 - 1) Appleton Electric Co.
 - 2) Crouse-Hinds.
 - c. Floor boxes:
 - 1) Hubbell Inc.
 - 2) Walker.
 - 3) Wiremold/Legrand.
 - d. Pullboxes:
 - 1) Circle AW Products.
 - 2) Hoffman Engineering Co.
 - 4. Precast concrete vaults:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
 - 5. J-Hooks Systems:
 - a. Erico nVent Caddy HP.
 - b. B-Line.
 - c. Panduit.
 - d. Mono-Systems, Inc.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.02 CONDUIT

- A. Electrical metallic tubing (EMT):

1. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.
 2. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2-inches. Setscrews shall be of case-hardened steel with combination head and cup point to firmly seat in wall of conduit for positive grounding.
 3. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
 4. Compression type couplings: Hot dip galvanized, Zinc plated steel or cast malleable iron, UL listed concrete tight, using ring compression type construction.
 5. Compression type connectors: Hot dip galvanized, Zinc plated steel or cast malleable iron, UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated, using ring compression type construction.
 6. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
 7. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.
- B. Rigid non-metallic conduit (PVC)
1. Conduit:
 - a. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90-degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 - b. Rigid polyvinyl chloride, Type EB or DB conforming to NEMA TC 6 and UL 651, latest edition, UL listed for concrete encased burial and direct burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 2. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.
- C. Miscellaneous conduit fittings and products:
1. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
 2. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.

3. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
4. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.
5. Standard products not herein specified:
 - a. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - b. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.
 - c. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.

2.03 FIRE-RATED WALL AND FLOOR THROUGH-PENETRATION

A. General:

1. Through-penetration firestop system shall have been tested for specific fire resistance rated construction conditions or acoustical and smoke related requirements conforming to construction assembly type, penetrating item type, annular space requirements, and rating involved for each separate instance.
2. Firestop rating shall match that of the wall or floor construction being penetrated.
3. Firestop systems shall be as outlined below:
 - a. Firestop putty.
 - b. Firestop putty pads.
 - c. Fire-rated cable pathways.

B. Firestop putty:

1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers, or silicone compounds.
2. Putty shall be used to seal openings around conduit penetrations through rated walls or floors, to maintain the construction rating.

C. Firestop putty pads:

1. Intumescent, non-hardening, pliable putty pads designed to seal both through and membrane penetrations against the spread of fire and smoke around outlet boxes in rated construction.
2. The pads are 6" x 8" x 0.125" thick.
3. Pads are rated for up to 4-hour rated wall assemblies.

D. Fire-rated cable pathway penetrations:

1. Cable pathway penetrations shall be used in fire-rated construction for low-voltage cabling, where cables pass through fire-rated wall or floor construction.
2. Cable pathways shall consist of an enclosed heavy-gauge galvanized steel housing lined with intumescent material engineered for rapid expansion when exposed to fire or high temperatures, quickly sealing the pathway, and preventing the passage of flames and smoke. The pathway shall be approximately 4" square x 14" long.
3. Cable pathways shall meet the hourly fire-rating of fire rated wall and/or floor penetrated.
4. Cable pathways shall be tested for the surrounding construction and cable types involved.
5. Pathways shall be UL Systems permitting cable loads from 0 to 100-percent fill. This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
6. Pathway shall be maintenance-free, having a corresponding Evaluation Services Report from a Nationally Recognized Third-Party Laboratory. Maintenance-free is defined as no action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
 - a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.
 - c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of "Maintenance-Free" and all relevant codes and standards.
7. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
8. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

2.04 OUTLET BOXES

A. Standard outlet box:

1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
2. 4.687-inch square by 2.125-inch deep shall be minimum box size.
3. ANSI/NEMA OS 1.

B. Concrete box:

1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.
2. Select height as necessary to position knockouts above concrete reinforcing steel.
3. ANSI/NEMA OS 1.

C. Pull and junction boxes:

1. Sheet metal pull and junction box:
 - a. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 - b. ANSI/NEMA OS 1.
2. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
3. Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.

2.05 VAULTS

A. Precast concrete: Concrete mix and reinforcing placement shall be in accordance with ACI 318. Design tops and wall structures for AASHTO H20 highway loading, with 30 percent loading added for impact. Walls shall withstand all soil pressures, taking into consideration the soil encountered and ground water level present at the Project site. Assume ground water level three feet below ground surface unless a higher water table is indicated in soils report.

B. Construction:

1. Monolithic or modular assembled sections.
2. Assembled sections shall have mating edges with tongue and groove joints. Joints shall firmly interlock adjoining components and provide waterproof junctions. Seal joints watertight using preformed plastic strip.
3. Provide lifting devices cast into units for proper handling of units.
4. Identify all structures with Manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
5. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

C. Size and dimensions: As indicated on Drawings.

D. Accessories:

1. Frames and covers: Cast iron with cast-in legend "COMMUNICATIONS" or "LOW-VOLTAGE" as appropriate. Machine cover-to-frame bearing surfaces.

2. Pulling eyes in walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load embedded in 6-inch, 4000-PSI concrete: 13,000 pounds minimum tension.
3. Pulling and lifting irons in floor: 7/8-inch diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.
4. Bolting inserts for cable stanchions: Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive thermoplastic material; 1/2-inch internal diameter by 2.75-inch deep, flared to 1.25-inch minimum at base. Tested ultimate pull-out strength at 12,000 pounds minimum.
5. Expansion anchors for installation after concrete is cast: Zinc-plated carbon steel wedge type with stainless-steel expander cup 1/2-inch bolt size, 5,300 pound rated pull-out strength and 6800 pound rated shear strength minimum.
6. Cable stanchions: Hot-rolled, hot-dipped, galvanized "T" section steel, two 1/4-inches size, punched with 14-holes on 1.5-inch centers for cable arm attachment.
7. Cable arms: 3/16-inch thick hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12-inches wide by 14-inches long and arranged for secure mounting in horizontal position at any position on cable stanchions.
8. Cable support insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.
9. Ground rods: Solid copper, 3/4-inch diameter by 10-feet length (minimum).
10. Ground wire: Stranded bare copper conductor, #6 AWG (minimum). Size in accordance with CEC Article 250.
11. Steps: Cast iron, suitable for shape and construction.

2.06 J-HOOK "NON-CONTINUOUS" CABLE SUPPORT SYSTEM

A. General:

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables per ANSI/TIA 568.0-D.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hook shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
4. J-hook shall have a hot-dipped galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. J-hook shall be made using a metal thickness of 0.052" and in a finish and hardness.
6. Attaching J-hooks and assemblies to ceiling support wires is not allowed per the CEC.

B. Multi-tiered field assemblies:

1. Multi-tiered J-hook assemblies shall be used where separate cabling compartments are required. Assemblies may be created by joining the J-hook with snap-on tree-mounting brackets. Assemblies can be made single-sided for wall-mount applications or single/double sided for ceiling/beam/threaded rod suspended applications. The assembly is rated for indoor use in non-corrosive environments.
 2. For installation on threaded rod, a snap-on angle bracket must be added on top of the assembly.
 3. If required, the multi-tier J-hook assembly can be attached to snap-on angle or straight brackets riveted to beam clamps, flange clips, angle brackets, etc.
- C. Factory assembled multi-tier J-hook assemblies: The assemblies shall be used where separate cabling compartments are required. These assemblies are assembled by the factory. Multi-tier assemblies are available for specific applications including wall mount, ceiling mount, threaded rod mount, and beam/flange mount. The beam/flange mount assembly shall include a beam clamp rated to hold the weight of any of the multi-tier configurations. Assemblies shall be available in 1, 2, 3, & 4 tier double-sided and 2, 3, & 4 tier in single-sided configurations. The assembly shall be rated for indoor use in non-corrosive environments.
- D. J-hook assemblies shall be furnished with appropriate fittings and add-on devices to allow for supports in multiple applications. Support fittings and add-on devices include beam or flange fasteners, threaded rod fasteners, support wire fasteners, construction channel support fasteners, wall or concrete or joist fasteners, raised access floor pedestal supports, etc.
- E. J-hook assemblies from acoustic tee bar: Acoustical tee bar bracket riveted to one 1" J-hook, factory assembled; rated for in-door use in non-corrosive environments. Request permission from local AHJ before using.
- F. Finishes: ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel, or ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic Coated by the Hot Dip Process
- G. Material: Base material of the J-hooks shall be metal (at least a 0.052" thickness). Any fasteners used to affix the J-hooks shall also be metal and shall be fastened to the metal of the J-hook support.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of pathway installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 CONDUIT APPLICATION

- A. Electrical metallic tubing (EMT): Shall be used exposed or concealed for interior communication conduits 4" and smaller, where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within communication rooms or closets.

B. Rigid non-metallic conduit (PVC): Shall be used in the following applications:

1. Direct burial ducts: Schedule 80, minimum 24-inches below finished grade.
2. Concrete encased ducts: Type DB, minimum 30-inches below finished grade.
3. Below building slab-on-grade: Schedule 80, minimum 4-inches below bottom of slab except that bends and penetrates through floor slab shall be insulated galvanized rigid steel conduit.
4. Below roads and paved surfaces:
 - a. Schedule 80, minimum 36-inches below finished grade.
 - b. Concrete encased type DB, minimum 30-inches below finished grade.
5. Utility pole riser: Schedule 80.
6. Penetrations of building and equipment slabs: Schedule 80 conduit.
7. Slope duct to drain towards vaults and away from building and equipment entrances. Pitch not less than 4-inches per 100-feet.
8. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 25-feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and equipment stub-ups.
9. For communications conduits, do not exceed a combined bend radius of greater than 180-degrees between pull points.
10. Underground conduit stub-ups to inside of building and exterior equipment shall be Schedule 80 conduit.
11. Make joints in ducts and fittings watertight according to Manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
12. Terminate duct lines at vaults with end bells spaced 10-inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing duct line slope and without forming trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrance.
13. Separation between direct buried duct lines shall be 3-inches minimum for like systems and 12-inches minimum between power and communication ducts.
14. Concrete encased ducts:
 - a. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts material throughout the installation.
 - b. Rigid PVC spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3-inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed 5-feet.
 - c. Provide non-ferrous tie wires to prevent displacement of the ducts during pouring of concrete.
 - d. Separate ducts 3-inches for like systems and 6-inches between power and signal ducts.

15. For direct burial installations install continuous warning strip of heavy gage plastic imprinted "communication ducts below", approximately 12-inch wide at 12-inches above ducts.

16. Mandrel all ducts upon completion of installation and prior to pulling cables.

3.03 PREPARATION

A. Conduit:

1. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
3. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
4. Communications conduits shall not be placed closer than 12-inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
5. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
6. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
7. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.
8. Communication conduit bends shall not exceed 180-degrees within any single run of conduit.
9. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.

B. Boxes:

1. Install all outlet boxes flush with building walls, ceilings, and floors.
2. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
3. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Adjust locations as required by structural conditions and to suit coordination requirements of other trades.

4. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
5. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.

C. J-hooks:

1. Location of J-hooks shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
2. J-hooks shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
3. J-hooks shall not be placed closer than 3-inches to any branch circuit power raceway.

3.04 INSTALLATION

A. Conduit:

1. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Minimum communication conduit size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1-1/4" for interior applications and 2" for exterior and underground applications.
3. All communication conduit sizes indicated on the Drawings are sized for 40-percent fill. If cable type or size is changed the Contractor shall be responsible for resizing conduits upward to meet a maximum 40-percent fill.
4. In general, all conduit work shall be concealed where possible. Exceptions shall be communication rooms, exposed ceiling areas, and parking garages.
5. Install conduits in complete runs before pulling in cables or wires.
6. Install conduit free from dents, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
7. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
8. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
9. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
10. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
11. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.

12. A run of communications conduit between terminations at wire pulling points shall not contain more than the equivalent of two-quarter bends (180-degrees, total).

13. All open conduit ends shall use a plastic bushing.

B. Fire-rated cable pathways:

1. Install cable pathways in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Install pathways using mounting plates and gasketing that comes with equipment for the application of each installation.
3. Where multi-gang pathway penetrations occur, use framing hardware brackets recommended by manufacturer for specific applications. Pathways shall be furnished with insert hooks and eye windows to connect units together and align them for multi-gang installations.

C. Boxes:

1. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Locate electrical boxes as indicated on Drawings.
3. Install junction or pullboxes where required to limit bends in conduit runs to not more than 180-degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
4. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
5. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
6. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
7. Welded outlet boxes shall only be used in concealed interior installations.
8. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.
9. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
10. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

D. Vaults:

1. Install precast assembly in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Install cast iron frame and cover. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1-inch above finished grade.

3. Units shall be installed on a level 12-inch bed of well-tamped gravel or crushed stone.
4. Install drains in bottom of units where indicated.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms and insulators, as required for installation and support of cable and conductors and as indicated.
6. Do not drill deeper than 3-7/8" for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.

E. J-hooks:

1. Install J-hooks in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Support J-hooks every 48-inches or less throughout the cable pathway.
3. J-hook support shall consist of 1/4" to 3/8" threaded rods supported from structure above, to structural wall studs with #10 wood or Tek screws or to #12 ceiling wire (independent of ceiling support) to structure.

3.05 PENETRATIONS

A. Conduit:

1. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - a. Where indicated on the Structural Drawings.
 - b. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
2. Cutting or holes:
 - a. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - b. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - c. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - d. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.
3. Sealing:

- a. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - b. Firestop: Where conduits and other communication raceways pass through fire-rated partitions, walls, smoke partitions or floor; install a UL classified fire-stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire-stop material.
4. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.
- a. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be Schedule 80 PVC conduit.
 - b. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.
 - c. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
 - d. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.06 CONDUIT CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 1-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to EMT conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3.07 UNDERGROUND CONDUIT INSTALLATION

- A. Perform trenching, backfilling and compaction operations as specified in Division 31: Trenching.
- B. Install service utility company underground conduits in strict conformance to each utility company's requirements. Obtain a copy of each utility company's installation guidelines prior to commencing Work.
- C. Tops of conduits shall be as follows unless otherwise noted:

1. Not less than 18-inches below finished grade.
 2. Not less than 30-inches below roadways, paved parking lots, driveways or any surface subject to vehicular traffic.
 3. Not less than 4-inches below building floor slab for branch circuits. Major feeders and large signal conduits (2" and greater) at not less than 18-inches.
- D. Depth of service utility conduits shall conform to utility company requirements.
- E. Furnish and install specified underground conduit marker 12" above conduits in trenches with all buried conduits.

3.08 CONDUIT TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Stub-up connections: Extend conduits through concrete minimum of 3" and terminate with insulated bushing.
- D. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- E. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.
 2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15-inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.

3.09 SUPPORTS

- A. Conduit:
1. Provide supports for raceways as specified in Section 270529: Communication Hangers and Supports.
 2. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
 3. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
 4. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel

rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.

5. Fasteners and supports in solid masonry and concrete:

- a. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
- b. After concrete installation:
 - 1) Steel expansion anchors not less than ¼ inch bolt size and not less than 1-1/8" embedment.
 - 2) Power set fasteners not less than ¼-inch diameter with depth of penetration not less than 3-inches.
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

6. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.

7. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

B. Boxes:

1. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
2. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
3. Support boxes independently of conduit system.
4. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
5. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

3.10 CLEANING

- A. Perform cleaning per Section 270010;
- B. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION 270528

SECTION 270529

COMMUNICATION HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Miscellaneous metals. Hangers for communication equipment.
 - 2. Division 09: Ceiling suspension systems. Slack support wires.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):

UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.03 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of communication equipment furnished and installed under Division 27.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.

B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.02 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.03 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

2.04 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.05 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch (nominal), 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1.5-inch on center in the base of the channel.

2.06 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
1. Use malleable strap with spacers for exterior and wet locations.
 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod

- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.

3.03 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 27.
- B. Telecommunication devices and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlets, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsumboard partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.
- J. Fabricate supports from 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.
- K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
- L. Bridge studs top and bottom with channels to support flush mounted cabinets in stud walls.

3.04 ERECTION OF METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.05 WOOD SUPPORTS

A. Cut, fit, and place wood nailers, blocking and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.06 ANCHORAGE

A. All floor mounted, free standing telecommunications equipment such as racks and cabinets etc., shall be securely fastened to the floor structure.

B. Anchorage of communication equipment shall comply with the seismic requirements as outlined in Section 270010: Basic Communication Requirements.

END OF SECTION 270529

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(Not for Bidding)

SECTION 270553

COMMUNICATION IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Equipment rack and cabinet nameplates.
 - 2. Fuse protector labels.
 - 3. Vertical and horizontal wire management labeling.
 - 4. Vertical and horizontal cable labeling
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA):
 - ANSI/TIA-606-D; Administration Standard for Telecommunications Infrastructure
 - 2. Electronics Industries Alliance (EIA):
 - EIA 230; Color Marking of Thermoplastic Wire.

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communication Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Schedules for nameplates to be furnished.

1.04 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Equipment rack and cabinet nameplates:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Great Lakes.
 - d. Panduit.
 - e. Ortronics.
2. Vertical and horizontal wire management labeling:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Panduit.

B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.02 NAMEPLATES FOR EQUIPMENT AND RACKS

- A. Engraved, plastic laminated labels, signs, and instruction plates. Engrave stock melamine plastic laminate 1/16-inch minimum thickness for signs up to 20 square inches or 6-inches in length and 1/8-inch thick for larger sizes. Engraved nameplates shall have white letters and be punched for mechanical fasteners.
- B. Color and letter height as specified in Part 3: Execution.

2.03 BACKBONE COPPER CABLING

- A. Labels type shall be durable plastic (PE or equal) tags, suitable for indoor and/or outdoor use, and shall contain UV inhibitors.
- B. Tags shall attach to the cable via an integrated tie or via a separate steel or plastic tie wrap.
- C. Machine printable with laser printer. Area shall be 1.50" by 2.62", minimum.
- D. Color: Gray tags with white tie-wraps for indoor locations and black tie-wraps for outdoor locations.

2.04 VERTICAL AND HORIZONTAL CABLE LABELS

- A. Fiber optic, twisted pair, and coaxial cables.
- B. Self-laminating adhesive laser labels with clear protective cover or heat shrink tube
- C. Machine printable with laser printer.
- D. Color: White with black lettering

2.05 OUTLET DEVICE COVERPLATES

- A. Top and bottom labeling windows for outlet identification
- B. Self-laminating, type-on-tape, adhesive labels.
- C. Imprinted or thermal transfer characters onto tape lettering system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of identification device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 NAMEPLATES

- A. Installation:
1. Degrease and clean surfaces to receive nameplates.
 2. Install nameplates parallel to equipment lines.
 3. Secure nameplates to equipment fronts using machine screws.
- B. Provide type 'NP' color coded nameplates that present, as applicable, the system and equipment designations.
- C. Nameplates for telecommunication systems equipment and devices are to be black.

3.03 BACKBONE CABLING

- A. General requirements:
1. Labeling, label colors, and identifier assignments shall conform to ANSI/EIA-606-C and TIA/EIA-606-C Administration Standards and as approved by the Owner.
 2. Provide permanent and machine-generated labels.
- B. Backbone cable labeling:

1. Cables:
 - a. Text color shall be black with #10 font size with a white background.
 - b. Identifier assignment Source/Destination:
 - 1) First field: Building, Floor, and Room number
 - 2) Second field: Rack or Cabinet ID
 - 3) Third field: Patch panel number at rack number
 - 4) Fourth field: Port number
 - 5) Example

a) 1A.AJ06-27:01 / 2A.AJ09-27:01

(1) 1A = Floor 1, Space A

(2) AJ06 = Rack or cabinet at grid location AJ06

(3) 27 = Patch panel 27

(4) :01 = Port 1

(5) / Repeat above for destination

- c. Label installation:

- 1) Provide labels on both ends of cables.
- 2) Install such that they are visible by a technician from normal stance.
- 3) Fully wrap label around the cable jacket (self-lamination).

- 4) Provide one label within 12" of the termination apparatus.
- 5) Provide one label at the point where the cable enters/exits the equipment room.
- 6) Provide one label at the approximate mid-point between where the cable enters/exits the room and the termination apparatus.
- d. Label installation:
 - 1) Install labels such that they are visible by technician from normal stance.
 - 2) Provide one label on the terminal cover or housing.
2. Fiber patch panels:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) Provide labels at each port.
 - 2) Install labels into label window.
3. Label installation in manholes/vaults/pullboxes:
 - a. Provide at least one label within the manholes/vaults/pullboxes.
 - b. Install labels such that they are visible by technician from above grade.
4. Label installation at splice points:
 - a. Provide one label on each side of splice case.
 - b. Install labels such that they are visible by technician from above grade.

3.04 HORIZONTAL CABLE LABELING

A. General requirements:

1. Labeling, label colors, and identifier assignments shall conform to ANSI/EIA-606-C and TIA/EIA-606-C Administration Standards and as approved by the Owner.
2. Provide permanent and machine-generated labels

B. Horizontal cable labeling

1. Text color shall be black with #10 font size with a white background.
2. Identifier assignment :
 - a. First field: Floor, and Room number
 - b. Second field: Rack or Cabinet ID
 - c. Third field: Patch panel number at rack unit number
 - d. Fourth field: Port number
 - e. Example

1) 1A.AJ06-27:01.LNK

- a) 1A = Floor 1, Space A
- b) AJ06 = Rack or cabinet at grid location AJ06

c) 27 = Patch panel 27

d) :01 = Port 1

C. Patch panels:

1. Text color shall be black, #10 font size.
2. Label installation:
 - a. Provide labels at each port.
 - b. Install labels into label window.

3.05 BUILDING ENTRANCE PROTECTOR (BEP) TERMINALS:

- A. Text color shall be black with #10 font size.
- B. Identifier assignment:
 1. First field: Building identifier.
 2. Second field: Building zone identifier.
 3. Third field: Incoming cable pair identifier.
 4. Fourth field: Outgoing cable pair identifier.

3.06 EQUIPMENT RACKS AND CABINETS

- A. Labeling and identifier assignments shall conform to the TIA-606-C Standard and as approved by the Owner before installation.
- B. Provide two label nameplates per rack. Permanently affix label nameplates centered on the rack's front top angle and back top angle.
- C. Provide two label nameplates per cabinet. Permanently affix label nameplates centered at the top of cabinet's front door and back door.

3.07 CABLING AND INSCRIBED DEVICE COVERPLATE

- A. General:
 1. Lettering type: Helvetica, 12-point or 1/8" high.
 2. Color of characters shall be black with white background
 3. Locate the top of the inscription 1/2" below the top edge of the cover plate.
 4. Inscription shall be centered and square with coverplates.
- B. Application:
 1. Provide inscribed cover plates for devices as outlined below:
 - a. Telecommunication outlets.
 2. Type-on-tape inscriptions shall be provided for the following devices:
 - a. Telecommunication outlets.
 3. Type-on-tape installation:
 - a. Tape shall be trimmed to the height of the letters.
 - b. Trim tape length to 1/4 inch back from each edge of labeling window

- c. Provide label within labeling window
- d. Contractor hands shall be clean or covered with surgical type glove prior to application of tape. Tape installations with visible fingerprints or smudges will not be acceptable.

3.08 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION 270553

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SECTION 271100

COMMUNICATION EQUIPMENT ROOMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Equipment racks.
 - 2. Vertical cable management.
 - 3. Horizontal cable management.
 - 4. Plywood Backboards
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA):
 - ANSI/TIA-569-D; Telecommunications Pathways and Spaces.
 - 2. American Society for Testing and Materials (ASTM):
 - ASTM E84; Surface Burning Characteristics of Building Materials
 - 3. Electronics Industries Alliance (EIA) / Electronic Components, Assemblies & Materials Association (ECA):
 - EIA/ECA-310-E; Cabinet, Racks, Panels, and Associated Equipment.

1.03 SYSTEM DESCRIPTION

- A. The work under this Section covers the materials, accessories, fasteners, etc., and all labor and services required to buildout the telecommunication equipment rooms per the Drawings and per these Specifications.
- B. Installation includes equipment racks, cabinets, cabling, cable management, cable terminations, plywood backboards, cable runways, and termination hardware to support communications equipment.
- C. Grounding system for bonding of equipment racks, cable runway, entrance conduits, riser conduits, etc. within the communication equipment room, specified under Section 270526: Communication Grounding and Bonding.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Shop Drawings to include:
 - a. Enlarged equipment room plans of the racks, cabinets, overhead cable runway, and conduit stubs into adjoining spaces.
 - b. Wall and rack elevations with scaled components.
 3. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 4. Submit Manufacturer's installation instructions.
 5. Provide qualifications support documentation per Part 1.06D(1) Quality Assurance
 6. Complete Bill of Material listing all components.
 7. Final test results.
 8. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that indicated on Drawings for the Engineer's approval.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communications Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Pictorial and schematic Electrical Drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
 5. Telephone numbers for the authorized parts and service distributors.
 6. Include all service bulletins and torque Specifications for all terminations.
 7. Final testing report.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this section may be used on the Project unless otherwise submitted.
- C. Manufacturer qualifications: Manufacturer must have a minimum 5 continuous years of experience in design and manufacturing of the materials and equipment specified herein.
- D. Installer's qualifications:

1. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide supporting information on 5 such Projects.
2. Installer shall possess a current, active, and valid C7 California State Contractors License, or operate a dedicated C7 division under a C10 California State Contractors License. All conduit and power shall be performed by a valid C10 California State Contractors License.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Equipment components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to manufacturer at no cost to Owner. Components shall be properly packaged in factory-fabricated containers and mounted on shipping skids.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment per Manufacturer's.

1.08 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1 or 2-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 1. Equipment Racks and Cabinets:
 - a. Chatsworth Product Inc. (CPI).
 - b. Belden Cable
 - c. B-Line
 - d. Panduit
 - e. APC
 - f. Great Lakes
 2. Power distribution unit (PDU) power strip:
 - a. APC Series #AP7532, Rack PDU
 - b. Chatsworth Product Inc. (CPI), Rack Unit.
 - c. Tripp-Lite, Rack Unit.

3. Vertical management sections:
 - a. Chatsworth Product Inc. (CPI).
 - b. Panduit.
 - c. Belden.
 4. Horizontal management panels:
 - a. Chatsworth Product Inc. (CPI).
 - b. Panduit.
 - c. Belden.
- B. Substitutions: Under provisions of Section 270010: Basic Communications Requirements.

2.02 FOUR-POST EQUIPMENT RACKS:

- A. Application: Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, and other similar equipment within a telecommunication room.
- B. Material: 11-Gauge ASTM A570 steel uprights and ASTM A36 steel angles.
- C. Channel:
 1. Size: 3" deep with flanges on each side (double sided).
 2. Flange: 1.265" wide by 0.25" thick with mounting holes.
 3. Mounting holes: Threaded mounting holes at #12-24 rolled and spaced 5/8", 5/8", 1/2" compatible with ANSI/EIA-310-D.
 4. RMU markings: The RMU markings shall be permanently stamped on the outside of both flanges on both channels.
- D. Assembled rack: All equipment racks shall be 4-post, complete with four mounting channels, two base angles (3.5" high by 6" deep by 0.375" thick), four top angles (1.5" high by 1.5" deep by 0.375" thick). Rack shall be 7'-0" high (overall) by 19" mounting width (20.25" width overall and shall contain 45 EIA mounting spaces (1.75" on center).
- E. Load rating: 2000-lbs, when evenly distributed for the height of rack.
- F. Finish: Powder coat, black.
- G. Accessories: Include required accessories, such as floor installation kits, seismic gusset kits, mounting hardware, etc. for a complete installation.

2.03 TWO-POST EQUIPMENT RACKS:

- A. Application: Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, and other similar equipment within a telecommunication room.
- B. Material: High-strength, lightweight, #6061-T6 extruded aluminum construction.
- C. Channel:
 1. Size: 3" deep with flanges on each side (double sided).

2. Flange: 1.265" wide by 0.25" thick with mounting holes.
 3. Mounting holes: Threaded mounting holes at #12-24 rolled and spaced 5/8", 5/8", 1/2" compatible with ANSI/EIA-310-D.
 4. RMU markings: The RMU markings shall be permanently stamped on the outside of both flanges on both channels.
- D. Assembled rack: All equipment racks shall be 2-post, complete with integrated mounting channels, two base angles (3.5" high by 6" deep by 0.375" thick), four top angles (1.5" high by 1.5" deep by 0.375" thick). Rack shall be 7'-0" high (overall) by 19" mounting width (20.25" width overall and shall contain 45 EIA mounting spaces (1.75" on center).
- E. Load rating: 1000 -lbs, when evenly distributed for the height of rack.
- F. Finish: Powder coat, black.
- G. Accessories: Include required accessories, such as floor installation kits, seismic gusset kits, mounting hardware, etc. for a complete installation.

2.04 EQUIPMENT CABINETS

- A. Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, computer equipment, and other similar equipment within a telecommunication room.
1. Material: Mounting holes: 3/8" Sq. Hole for cage nut hardware, horizontally spaced to 19", compatible with ANSI/EIA-310-D.
- B. Assembled rack: All equipment cabinets shall be floor standing, complete with integrated mounting channels. Shall include side, top and bottom panels. Shall include front and rear doors. Rack shall be 7'-0" high (overall) by 19" mounting width (23.62" width overall and shall contain 45 EIA mounting spaces (1.75" on center).
- C. Load rating: 3000-lbs static load.
1. 1500-lbs seismic load
- D. Finish: Powder coat, black.
- E. Accessories: Include required accessories, such as floor installation kits, seismic gusset kits, mounting hardware, cable grommets, etc. for a complete installation. Coordinate door type and locking type with Owner IT.

2.05 WALL MOUNT RACKS

- A. Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, computer equipment, and other similar equipment within a telecommunication room.
- B. Material: 14-Gauge steel body.
1. Mounting holes: Threaded mounting holes at #12-24 rolled and spaced 5/8", 5/8", 1/2" compatible with ANSI/EIA-310-D.
- C. Assembled rack:
1. Rear Section: 5.28 inches (133 mm) deep independent locking rear section with 16 inches C-to-C holes for mounting to the wall. 1", 2", 3" nominal concentric

conduit knockouts are available on topsides. Integral support shelf providing base for center section to be supported.

2. Center Section: 23.81 i(610mm) wide by 24.29 inches (617mm) deep center swing-out section provides front & rear access to cables. Heavy duty hinges come preinstalled. Draw latches are included for additional support and ease of lock operation when under the load. Integral roller to provide smooth travel across rear section support shelf.

D. Load rating: 200 lbs

E. Finish: Powder coat, black

F. Accessories: Include required accessories, such as floor installation kits, seismic gusset kits, mounting hardware, cable grommets, etc. for a complete installation. Coordinate door type and locking type with Owner IT.

2.06 VERTICAL CABLE MANAGEMENT

- A. Suitable for cable routing (back), cord routing, and cord slack storage (front) vertically within a rack bay, from bottom of rack to the top.
- B. The vertical management sections shall be double-sided having covered cable guides on the front and flip-retainers on the rear.
- C. Size and capacity between racks: Matching rack height by 10" wide by 16.15" deep minimum.
- D. Size and capacity at end of racks: Matching rack height by 6" wide by 16.15" deep minimum.
- E. Finish: Black, guide and cover.

2.07 HORIZONTAL CABLE MANAGEMENT

- A. Suitable for installation into equipment rack for horizontal cord management. The horizontal management panel shall match (and fully integrate with) the vertical management sections.
- B. The horizontal management panel shall be double-sided.
- C. Size: 1U, 2U, or 3U high by 19" mounting.
- D. Finish: Black, guide and cover.

2.08 PLYWOOD BACKBOARDS

- A. Plywood backboards shall be placed on all walls of the telecommunications equipment room. The plywood will support wall mounted equipment, termination blocks, cable runways, etc.
- B. Plywood backboards shall be A-C grade, fire treated, 3/4" thick by 8' high by 4' wide, void free and sanded one side.
- C. Paint plywood with 2 coats of fire-retardant paint on both sides and edges. Color to match painted interior. Leave one fire rated stamp visible on each plywood board.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of equipment installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 APPLICATION

- A. Provide support equipment in telecommunications equipment rooms to support cable infrastructure, network equipment, horizontal cabling, patch cords and entrance cable.

3.03 EQUIPMENT RACKS AND WALL-MOUNTED ENCLOSURES

- A. Installation:
 - 1. Equipment racks shall be mounted per construction drawings.
 - 2. Mount equipment racks per dimensions stated on the construction drawings to allow proper clearances and preserve future growth.
 - 3. Equipment racks shall be mounted square and level.
 - 4. Each equipment rack and cabinets shall be bonded to the Telecommunication Grounding Busbar per Section 270526 and construction drawings. Daisy-chaining racks are not allowed.
 - 5. Wall-mounted enclosures shall be mounted to the wall studs per construction drawings. Pre-drill plywood backboards prior to mounting to assure proper stud anchoring.
 - 6. Wall-mounted enclosures shall be mounted level. Coordinate mounting rail clearance with Owner.
 - 7. Wall-mounted enclosures shall be mounted so they can swing open with proper clearances. Cables shall maintain proper slack to allow opening of enclosures.
 - 8. Wall-mounted enclosures shall be bonded to the Telecommunication Grounding Busbar or electrical panel ground bus, per Section 270526 and construction drawings.

3.04 PDU POWER STRIPS

- A. Install vertical power strips as shown on Drawings or as specified herein. Power strips shall be located on the back side, one on each side. Install fasteners and parts as required, per manufacturers instructions, as required for proper supports.
- B. Route the input cords within designated cable management and provide cord fasteners to prevent movement of the input cords. Plug the input cords into the receptacle the designated for the purpose.

3.05 CABLE MANAGEMENT

- A. Vertical Cable Managers
 - 1. All equipment racks shall contain vertical managers between racks and on each end of racks.
 - 2. Attach managers securely to equipment racks.
 - 3. Provide cable protection with radius drops or plastic inserts into managers that allow cables to be free of kinks or cuts.

B. Horizontal Cable Managers

1. All equipment racks shall contain horizontal managers between all patch panels and equipment.
2. Secure managers with at least four rack screws.
3. Utilize managers on the backs of all premises cable equipment racks to properly dress cable terminations.

3.06 PLYWOOD BACKBOARDS

- A. Plywood shall be installed 8" above finished floor with stamped and sanded side out. Install around all walls of Telecommunications room.
- B. Secure plywood in backing or studs with galvanized, zinc plated or stainless steel stainless, #12 flat head screws (Wood or STS) as required with 8" spacing on edges and 12" in the field. Pilot and countersink screws to prevent splitting and provide flush mounting surface.

3.07 MISCELLANEOUS EQUIPMENT

- A. For the complete installation of Communication Equipment Rooms, the following equipment would also be required, but are each covered elsewhere in this Division of Work:
 1. Communication cabling.
 2. Communication termination blocks and accessory hardware.
 3. Communication cable runways.
 4. Communication grounding and bonding.
- B. Refer to other Sections of this Division for specific requirements for the installation of the above equipment.

3.08 FIELD QUALITY CONTROL

- A. At least three weeks prior to any testing, notify the Owner's Representative so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Owner's Representative's witnessed test.
- B. Test equipment racks to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to Section 270526 for testing and test methods.
- C. Visual and mechanical inspection:
 1. Visually inspect all rack support hardware and structural supports for loose bolts, nuts and other connection hardware that could cause the mechanical failure of cable support systems.
 2. Inspect ground connections to conduits, cable runway, equipment racks, BEP's, backbone cables and bus bars for mechanical integrity of the bond between ground cable and grounded equipment.
 3. Inspect the ground bus between electrical ground and each bus bar in system.

- D. In the event that the system fails to function properly during the testing as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Owner's Representative's hourly rate.
- E. Contractor shall replace at no costs to the Owner, all equipment and devices which are found defective or do not operate within factory specified tolerances.
- F. Contractor shall submit final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.09 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION 271100

SECTION 271313 COMMUNICATION BACKBONE COPPER CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Outside Plant (OSP) backbone twisted pair cable.
 - 2. Inside Plant (ISP) backbone twisted pair cable.
 - 3. Inside Plant (ISP) backbone twisted pair tie cable.
 - 4. Building entrance fused protector blocks.
 - 5. Backbone cable terminations.
 - 6. Cross-connect wiring.
 - 7. Cable testing equipment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Insulated Cable Engineers Association (ICEA):

ANSI/ICEA S-90-661; Category 3, 5, and 5e Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems.

ICEA S-116-732-2013; Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With Or Without An Overall Shield) for Use In LAN Communication Wiring Systems

- 2. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):

ANSI/TIA/EIA-758; Customer-Owner Outside Plant Telecommunications Cabling Standard (TIA/EIA-758-1: Addendum No. 1).

- 3. Electronics Industries Alliance (EIA):

EIA 230; Color Marking of Thermoplastic Wire.

- 4. National Fire Protection Agency (NFPA):

NFPA 255; Standard Method of Test of Surface Burning Characteristics of Building Materials

NFPA 259;
Materials

Standard Test Method for Potential Heat of Building

NFPA 262;
Wires and Cables for use in Air-Handling Spaces

Standard Method of Test for Flame Travel and Smoke of

5. Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):

TIA/EIA-568-E;
Components Standards

Balanced Twisted Pair Telecommunications Cabling and

TIA 569;

Telecommunications Pathways and Spaces

6. Underwriters Laboratories, Inc. (UL):

UL 444;

Communications Cables

UL 497;

Protectors for Paired-Conductor Communication Circuits

UL 497A;

Secondary Protectors for Communication Circuits

UL 497B;
Circuits

Protectors for Data Communications and Fire Alarm

UL 1863;

Communication-Circuit Accessories

1.03 SYSTEM DESCRIPTION

- A. Provide a complete copper backbone cabling system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:

1. OSP backbone twisted pair cabling:

- a. OSP cable shall be routed underground in PVC conduit(s) between buildings from the main distribution facility (MDF) cross-connect room of one building to the BDF rooms of other buildings, in a star topology, and shall consist of one multi-conductor pair, Category 5e, UTP, OSP, filled copper cable.
- b. Provide Splice cases in manholes and/or vaults to distribute inter-building copper cable to buildings.
- c. Provide splice cases for transitioning between filled OSP cable and ISP riser cable prior to termination on punchdown blocks in MDF, BDF, entrance room (ER), or MPOE for service entrances.
- d. Terminate backbone twisted pair cables on , wall-mounted, 110 style, BEP blocks within communication equipment rooms.

2. ISP backbone twisted pair cabling:

- a. ISP cable shall be routed between the MDF or BDF at each building and the IDF/TR rooms throughout the same building, in a star topology without the use of intermediate patching at any point, and shall consist of multi-pair, Category 5e, ISP, UTP copper cables.
- b. Terminate copper backbone cables on, wall-mounted, 110 style punchdown blocks at the MPOE or ER, MDF, BDF and IDF/TER rooms.

- c. Include cross-connect cabling for 33% of the riser to each IDF/TR at the MDF or BDF. Cross-connect the site entrance cable to the riser cable.
- 3. ISP backbone twisted pair tie cabling:
 - a. Tie copper field with wall mounted 110 style punch down blocks for cross-connect purposes with adjacent backbone field at IDF/TR rooms. 110 blocks shall be wired to 25-pair Category 5e power sum cables to interface with rack mounted 24 port, Category 5e voice field patch panels. Include one pair per port.
 - b. Include cross-connect cabling between 110 block backbone field and 110 block voice/patch field.
 - c. Wire management shall be provided above and below each 24-port patch panel, 2 RU at the equipment rack. Wire management troughs shall be provided above and below 110 blocks.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communication Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment, dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings prepare in Revit, to include the following:
 - a. Site plans indicating the cable origination, destination for each cable, and splice points. Drawings shall indicate cable pair count, cable pair splice count, cable spare pair count.
 - b. Building floor plans showing location of all outlets and cable routing to each device at same scale as construction documents.
 - c. Riser diagram(s) indicating all major components of copper cabling system with required cable inter-ties and backbone cable identification labels.
 - d. Provide 1/4" scale plans of equipment layout in MPOE, ER, MDF, BDF, and IDF/TR rooms.
 - e. Provide wall elevations of MPOE, ER, MDF, BDF, and IDF/TR rooms at 1/4" scale.
 - f. Provide equipment rack elevations at 1/4" scale.
 - g. Use identical symbols as those used in construction documents.
 - h. Text shall be a minimum of 3/32" high when plotted at full scale.
 - i. Screen all background information.
 - j. Splice case mounting details in manholes, vaults. And equipment rooms.

5. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communication Requirements.
 6. Submit Manufacturer's installation instructions.
 7. Complete Bill of Material listing all components.
 8. Final test results.
 9. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.05 OPERATION AND MAINTENANCE MANUALS

1. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communication Requirements, to include the following:
2. A detailed explanation of the operation of the system.
3. Instructions for routine maintenance.
4. Pictorial parts list and part numbers.
5. Schematic wiring diagrams.
6. Telephone numbers for the authorized parts and service distributors.
7. Final testing report.

1.06 QUALITY ASSURANCE

- A. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide supporting information on 5 such Projects.
- B. Installer shall possess a current, active, and valid C7 California State Contractors License, or operate a dedicated C7 division. under a C10 California State Contractors License.
- C. All conduit and power shall be performed by a valid C10 California State Contractors License.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Equipment components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to manufacturer at no cost to Owner. Components shall be properly packaged in factory-fabricated containers and mounted on shipping skids.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged

units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. OSP copper and components offered under this Section shall be covered by a minimum 10-year product and application warranty for malfunctions resulting from defects in materials, workmanship and performance as specified by the manufacturer. Warranty shall begin upon acceptance by the owner.
- B. ISP copper riser and horizontal copper cable and components offered under this Section shall be covered by a minimum 25-year product and application warranty for malfunctions resulting from defects in materials, workmanship and performance as specified by the manufacturer. Warranty shall begin upon acceptance by the owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Backbone cables and termination blocks:
 - a. Superior Essex Cable
 - b. General Cable
 - c. CommScope
 - d. Belden Cabling System
 - 2. Splice case 710 modules:
 - a. 3M
 - b. AT&T
 - 3. Building Entrance Protectors:
 - a. Circa
 - b. Porta Systems
 - c. Systemax
 - 4. Cable test equipment:
 - a. Fluke Networks
 - b. Agilent Technologies WireScope 350 Test Set
 - c. Tektronix
- B. Substitutions: Under provisions of Section 270010: Basic Communication Requirements.

2.02 OSP BACKBONE TWISTED PAIR CABLE

- A. Application:
 - 1. Suitable for outdoor installations in underground PVC conduits.
 - 2. Each cable run shall be a continuous single cable, homogenous in nature, without splices.

3. Twisted pair type cable with filled core and ASP sheath, compatible with Bell System type ANMW or Rural Utilities Service type PE 89.

B. Conductors:

1. Annealed solid copper, #24 AWG.
2. Fully insulated conductors consisting of an inner layer of expanded polyolefin and covered with an outer layer (skin) of solid polyolefin.
3. Multi-conductor Category 5e cable.
4. Conductors shall be twisted into pairs. Twisted pairs shall be stranded into 25-pair bundles and into larger units of 25-pair increments, to make up the specified pair count, as well as super units (if required by pair count).
5. Twisted pairs and units shall be color-coded to industry standards per EIA 230.

C. Core and sheath:

1. Cable core (twisted pairs) shall have a tape applied longitudinally, wrapped around its entirety. Tape material shall be non-hydroscopic polypropylene film or equivalent.
2. Cable core and sheath shall be flooded with filling compound "FLEXGEL," or equal, to protect against moisture penetration.
3. Sheath type shall be "ASP" consisting of a two-layer inner shield and an outer jacket:
 - a. Shield:
 - 1) 0.008" corrugated aluminum tape applied longitudinally over the core wrap.
 - 2) 0.006" corrugated steel tape applied longitudinally over the aluminum tape with an overlap.
 - b. Jacket: Black, linear low-density polyethylene, bonded to shield.

D. Splice case modules:

1. Modules shall contain an insulation displacement connection (IDC) device. The electrical connections are made by metallic contact elements that displace the insulation, creating a contact point between the conductor and the contact element.
2. The module design provides a gas-tight connection.
3. Strain relief is achieved through plastic sheath retention grip points, maintaining retention on conductor insulation.
4. Modules shall accommodate 25-pairs of PIC or PVC insulated copper twisted-pair conductors, gel-filled OSP type, in sizes ranging from #22 to #26 AWG.
5. Module shall be constructed of flame-retardant engineering grade plastic. Each module contains its own moisture-resistant compound that is pressed outward when the body and index strip or cap are pressed together. The preloaded compound is designed to fill all voids to eliminate air or moisture pockets that could surround the contacts and/or conductors.

2.03 ISP BACKBONE TWISTED PAIR CABLE

A. Application:

1. Suitable for indoor installations, between floors exposed in equipment rooms as vertical risers, or above suspended ceilings and below raised floors exposed in cable trays, hangers or on deck. If space is used as an air plenum, cable shall either be plenum rated or installed in EMT conduit.
2. Each cable run shall be continuous single cable, homogenous in nature, without splices.
3. Multipair cable shall be CMP when installed exposed above ceiling space. Cable shall be CMR rated when installed in conduit when passing between floors and other telecommunications equipment rooms.

B. Conductors:

1. Annealed solid copper, 24 AWG.
2. Fully insulated conductors consisting of an inner layer of expanded polyolefin and covered with an outer layer (skin) of solid PVC.
3. Multi-conductor Category 5e cable.
4. Conductors shall be twisted into pairs. Twisted pairs shall be stranded into 25-pair bundles and into larger units of 25-pair increments, to make up the specified pair count, as well as supper units (if required by pair count).
5. Twisted pairs and units shall be color-coded to industry standards (EIA-230).

C. Core and sheath:

1. Cable core (twisted pairs) shall have a tape applied longitudinally, wrapped around its entirety. Tape material shall be non-hydroscopic polypropylene film or equivalent.
2. Sheath type shall consist of an inner shield and an outer jacket:
 - a. Shield: 0.008" aluminum corrugated tape applied longitudinally with an overlap.
 - b. Jacket: Flame-retardant PVC, adhesively bonded to shield.

D. Cable shall be CMR or CMP cable and UL listed as such.

E. Electrical performance of the twisted pairs and overall cable shall comply with TIA/EIA-568-C Part 2 requirements for Category 5e UTP cabling, minimum.

2.04 ISP BACKBONE TWISTED PAIR TIE CABLE

A. Application:

1. Suitable for indoor installations, exposed within telecommunication rooms on cable runway. Each cable run shall be continuous single 25-pair cable, homogenous in nature, without splices, to provide support for backbone and horizontal applications analog telephone circuits. To bring the backbone analog telephone circuit to the data equipment rack telephone patch panel.
2. Cables shall meet Category 5e power sum performance criteria.
3. Cables shall be CMR or CMP rated.

B. Conductors:

1. 25-pair, twisted, # 23 AWG, solid copper wire insulated with thermoplastic polyethylene for non-plenum rated application or FEP for plenum rated applications.
2. Two insulated conductors twisted together to form a pair and twenty-five such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/TIA-568-C or ANSI/TIA-568-D).

C. Cable sheath:

1. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
2. CMP according to CEC Chapter 8, tested to NFPA 262 and UL Listed as such.

D. Electrical performance: Shall meet or exceed TIA/EIA-568-D Enhanced and ISO 11801 Class F Specifications for CAT5e UTP Cabling or TIA/EIA-568-C-2 Specifications for CAT3 UTP Cabling.

2.05 BUILDING ENTRANCE PROTECTORS (BEP)

A. Provide protection of equipment and personnel from power surges and lightning strikes via termination of outside plant cables to building entrance protection "BEP" blocks.

B. BEP terminals:

1. Suitable for indoor installations, within equipment rooms (such as MPOE, ER, MDF and BDF). Provide termination of outside plant twisted pair backbone cables to BEP terminals to protect premise equipment against induced voltages and stray currents. BEP terminals shall accept 5-pin protector modules.
2. BEP terminals shall be designed for wall mounted configurations and shall have the capacity to accept 50 to 100-pair incoming and/or outgoing cable pairs.
3. 710-type input splice modules.
4. 25 pair BEP output cables to 110 blocks.

C. BEP modules:

1. Standard 5-pin type BEP, suitable for installation into BEP terminals.
2. Gas tube overvoltage device with DC breakdown voltage of 230-350V.
3. Heat coil sneak current device with 1.0 amp of sneak current and response time less than 15-seconds.

2.06 BACKBONE TWISTED PAIR TERMINATIONS:

A. Outside plant cables: Terminate all OSP cables to building entrance protection "BEP" blocks. Refer to Specification Section 271100: Communication Equipment Rooms for BEP requirements.

B. Inside plant cables:

1. Suitable for indoor installation within equipment rooms for termination of twisted pair backbone cables, either wall or rack mounted, vertically oriented in wall mount column configuration.

2. Wall mounted 110 block type. Provide kits as required for 100, 300 or 900-pair, 5-pair based.
3. 110 style vertical wire managers as required.
4. Insulated displacement connector blocks consisting of oxygen free mechanical fastening system, arranged in a flame-retardant molded plastic, and fastened to a mounting bracket.

2.07 CROSS-CONNECT WIRES:

- A. Cross-connect wires shall be suitable for installation within the MPOE, ER, MDF, BDF, and IDF/TR, and shall be fully compatible with the termination apparatus specified within this Section.
- B. Cross-connect wires shall be manufactured from a single, continuous length of insulated wire, homogenous in nature. Splices are not permitted anywhere.
- C. Conductors:
 1. Insulated conductors: #24 AWG, solid copper wire insulated with thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 2. Twisted pairs: Two insulated conductors twisted together to form a pair with individually color-coded pairs to conform to industry standards (EIA-230).

2.08 CABLE TESTING EQUIPMENT

- A. Equipment shall meet TIA/EIA-568C.2 Addendum 1 requirements for Level III accuracy, as applicable for cable type specified herein.
- B. Test standards: ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-Y, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5.
- C. Areas of test measurement (minimum):
 1. Wire Map.
 2. Length.
 3. Insertion Loss.
 4. The following at both master unit and remote unit:
 - a. Near End Crosstalk (NEXT) loss.
 - b. Power Sum NEXT (PSNEXT) loss.
 - c. Equal Level Far End Crosstalk (ELFEXT).
 - d. Power Sum ELFEXT.
 - e. Return Loss (RL).
 - f. Attenuation-to-Crosstalk Ratio (ACR).
 - g. Power Sum ACR (PSACR).
 5. Propagation Delay and Delay Skew.
 6. Characteristic Impedance.
 7. DC Loop Resistance.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the backbone cabling system installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are satisfied.
- B. Verify that pathways and supporting devices are properly and completely installed prior to cable installation.
- C. Verify dimensions of pathways to include length, i.e. "true tape" conduit runs.
- D. Prior to installation, verify that the MPOE, ER, MDF, BDF, and IDF/TR rooms are ready to accept cables and terminations.

3.02 INSTALLATION

- A. OSP backbone twisted pair cabling:
 - 1. Cabling:
 - a. Cable runs shall have continuous sheath continuity, homogenous in nature, between either termination points or designated splice points. Only splices as noted on the Construction Documents are permitted.
 - b. Maximum cable length of 2,625 feet between the termination points.
 - c. Placement:
 - 1) Place cables within designated pathways.
 - 2) Maintain a minimum bend radius of 30 times the cable diameter during and after installation. Follow manufacturers specifications.
 - 3) Maintain pulling tension within manufacturer's limits. Only use UL approved cable pulling compounds when necessary to reduce pulling tensions.
 - 4) Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation.
 - 5) Neatly dress and organize cables in the cable routing facilities and fasten to support devices via tie wraps.
 - d. Routing:
 - 1) When routing horizontally within equipment rooms, utilize the overhead cable runway system. Within overhead cable support, route backbone cables to avoid crossing over horizontal cabling or horizontal cabling crossing over backbone cables. When routing vertically within equipment rooms, utilize the vertical cable support system and provide approved cable straps at 24" intervals.
 - 2) Route cables a minimum of 6" away from power sources to reduce interference from EMI.
 - e. Terminations:
 - 1) Properly relieve strain from cables at termination points per manufacturer's recommendations.

- 2) Bond metallic components of the cable sheath (i.e. shield) to the telecommunication ground system in accordance with the CEC and manufacturer's instructions.
 - 3) Terminate twisted pairs at both ends onto the specified BEP terminals. Perform terminations in accordance with manufacturer's latest instructions and TIA/EIA-568-C standard installation practices.
2. Building entrance protection:
- a. Provide BEP system to include terminals, modules and accessories required for a complete installation. Install BEP per manufacturer's written instructions.
 - b. Install BEP terminals plumb and square with building lines. Install such that the bottom row of terminations is no lower than 24" above finished floor and the top row of terminations is no higher than 60" above finished floor.
 - c. Grounding and bonding:
 - 1) Bond BEP terminals to the telecommunication ground system in accordance with the CEC and per the manufacturer's instructions.
 - 2) Provide #6 AWG bonding conductor.
 - d. Provide quantity of protector modules to completely populate terminals.
3. Cross Connecting: Provide 1-pair cross connect to 33% of the riser cable at the MDF/BDF and IDF/TR.
- B. ISP backbone twisted pair cabling:
1. Cabling:
 - a. Cable runs shall have continuous sheath continuity, homogenous in nature, without any splices.
 - b. Maximum cable length of 1,600 feet (500m) between the terminations at MDF/BDF and IDF/TR.
 - c. Placement:
 - 1) Place cables within designated pathways.
 - 2) Maintain a minimum bend radius of 20 times the cable diameter during and after installation.
 - 3) Maintain pulling tension within manufacturer's limits.
 - 4) Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation.
 - 5) Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of pull rope.
 - d. Routing:
 - 1) When routing horizontally within equipment rooms, utilize the overhead cable runway system. When routing vertically within equipment rooms,

utilize the vertical cable support system and provide approved cable straps at 24" intervals.

- 2) Route cables a minimum of 6" away from power sources to reduce interference from EMI.

e. Terminations:

- 1) Properly relieve strain from cables at termination points per manufacturer's recommendations.
- 2) Bond metallic components of the cable sheath (i.e. shield) to the telecommunication ground system in accordance with the CEC and manufacturer's instructions.
- 3) Terminate twisted pairs onto the termination apparatus in accordance with manufacturer's latest instructions and TIA/EIA-568-C standard installation practices.

2. Termination apparatus:

- a. Provide accessories required for a complete installation.
- b. Install the termination apparatus such that the bottom row of terminations is no lower than 24" above finished floor and the top row of terminations is no higher than 60" above finished floor.
- c. Mount termination apparatus plumb and square to building lines.

3.03 FIELD QUALITY CONTROL AND TESTING

A. General:

1. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
2. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Owner's Representative discretion, halt testing activity and clean testing equipment, test cords and related apparatus.
3. Permanently record test results electronically within test equipment at the time of testing.

B. Twisted pair testing:

1. Test for UTP cabling as follows:

TESTS FOR TWISTED PAIR CABLING TABLE				
Subsystem	Type	Test	Configuration	Notes
Backbone	OSP	See Notes	-	Wire map & length
Backbone	ISP/Riser	See Notes	-	Wire map & length

2. Precautions:

- a. Adhere to the equipment manufacturer's instructions during all testing.

- b. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature, approximately 70-degree F.
 - c. Fully charge power sources before each day's testing activity.
 - 3. Backbone twisted pair testing:
 - a. The installation will be accepted when testing has indicated availability of 100% terminated pairs.
 - b. Test continuity and wire map for all pairs.
 - c. Test length for 2% of pairs of each cable. Pairs shall be from different 25 pair binder groups.
- C. Record documents:
 - 1. Permanently record all test results.
 - 2. Export test results' numerical values to a single Microsoft Excel spreadsheet.
 - 3. Submit test results in a format acceptable to the Owner or Owner's Representative before system acceptance.
 - 4. Cable pair identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
 - 5. Measurements shall carry a precision through one significant decimal place, minimum.
 - 6. Use feet for the units for measurements shown on the print of the test measurements.
 - 7. For each twisted pair backbone cable test, report shall contain the following information:
 - a. Project name and address.
 - b. Test company's and Operator's name.
 - c. Date measurements were taken.
 - d. Test equipment type to include model and serial numbers.
 - e. Cable identification number and pair number.
 - f. Measurement results.

3.04 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Owner's Representative prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the communication cabling system by this Contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship

are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.05 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Clean installed products in accordance with manufacturer's instructions prior to final punchlist.

3.06 TRAINING

- A. At the completion of all Work, a period of not less than 2 hours shall be allocated by the Contractor for instruction and training for the Owner Representative. The Cabling Contractor will need to describe how the cable is separated between different patch panels, how cross-connects are made and other basic cable plant management skills.
- B. Contractor shall schedule training with a minimum of 7 days advance notice.

END OF SECTION

SECTION 271323

COMMUNICATION BACKBONE FIBER OPTIC CABLING PART 1 -

GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. OSP backbone fiber optic cabling.
 - 2. ISP backbone fiber optic cabling.
 - 3. Backbone fiber optic cable terminations.
 - 4. Innerduct
 - 5. Cable testing equipment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):

ANSI/TIA/EIA-568-D; Commercial Building Telecommunications Cabling Standards, including the following:

Part 3: Optical Fiber Cabling Components Standard.

ANSI/TIA/EIA-598-D; Optical Fiber Cable Color Coding. ANSI/TIA/EIA-606-D;

Administration Standard for Commercial Telecommunications Infrastructure.

ANSI/TIA/EIA-758-C; Customer-Owner Outside Plant Telecommunications Cabling Standard (TIA/EIA-758-1: Addendum No. 1).

- 2. Building Industry Consulting Service International, Inc. (BICSI):

BICSI (TDMM); Telecommunication Distribution Methods Manual.

BICSI; Customer-Owner Outside Plant Design Manual.

- 3. Insulated Cable Engineers Association (ICEA):

ICEA S-83-596; Fiber Optic Premises Distribution Cable.

ICEA S-87-640; Fiber Optic Outside Plant Communications Cable.

ICEA S-104-696; Standard for Indoor-Outdoor Optical Cable.

- 4. National Fire Protection Agency (NFPA):

NFPA 255;
Characteristics of Building Materials

Standard Method of Test of Surface Burning

NFPA 259;

Standard Test Method for Potential Heat of Building
Materials

NFPA 262;
Wires and Cables for use in Air-Handling Spaces

Standard Method of Test for Flame Travel and Smoke of

5. Underwriters Laboratories, Inc. (UL):

UL 1651;

Optical Fiber Cable.

UL 2024A;

Optical Fiber Cable Routing Assemblies.

1.03 SYSTEM DESCRIPTION

A. Provide a complete communication optical fiber backbone cabling system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:

1. OSP backbone fiber optic cabling:

- a. OSP backbone fiber optic cable shall be routed underground in PVC conduit(s) between buildings from the main distribution facility (MDF) room of one building to the BDF rooms of other buildings, in a star topology. Cable will be placed in innerduct for routing within conduit. Refer to construction documents for fiber optic cable quantities and types.
- b. OSP backbone fiber optic cables shall terminate on full height racks in the MDF or BDF rooms. The cable ends will be fusion spliced to SMF pigtails with manufacturer terminated LC connectors and placed in LC connector plates.
- c. OSP backbone fiber optic patch panel field shall interface with ISP backbone fiber optic patch panel field via fiber patch cords between modular connectors on the front side of patch panels.
- d. OSP fiber optic cable connector standard shall be Type LC. Connectors shall be simplex type.

2. ISP backbone fiber optic cabling:

- a. ISP backbone fiber optic cable shall be routed between the MDF or BDF and the IDF/TR rooms in the same building per construction documents. The IDF shall connect directly from the MDF or BDF in a star topology without requiring an intermediate patch at any other point.
- b. ISP backbone fiber optic cables shall terminate on same rack as OSP backbone fiber at the MDF or BDF room, utilizing rack mounted LC patch panels as required, with patch cord management integrated into each panel. Locate the ISP backbone patch field just below the OSP patch field at the MDF or BDF. At the IDF/TR rooms, locate rack mounted, 24-port patch panels at top of full height dedicated racks with patch cord management integrated into the patch panels.
- c. ISP fiber optic backbone cables shall terminate on backside of fiber patch panels.

- d. ISP backbone fiber optic patch panel field shall interface with routing/switching equipment, furnished by Owner, at the MDF or BDF and IDF/TR rooms via fiber patch cords from modular connectors on patch panel front side.
 - e. ISP Fiber optic cable connector standard shall be Type LC. Connectors shall be simplex type.
 - 3. Patch cords:
 - a. LC to LC duplex fiber patch cords shall be provided to patch between the OSP and ISP fiber cables.
 - b. Provide duplex patch cords as required to patch between backbone fiber optic (LC) and equipment SC/LC/FC connectors, as required. Coordinate with Owner's IT Representative.
- B. Refer to Drawings for complete documentation of above requirements and all additional requirements.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communication Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment, dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings prepare in Revit, to include the following:
 - a. Building floor plans showing location of all outlets and cable routing to each device at same scale as construction documents.
 - b. Riser diagram(s) indicating all major components of fiber optic system with required cable inter-ties and backbone cable identification labels.
 - c. Provide 1/4" scale plans of equipment layout in MPOE, ER, MDF, BDF, and IDF/TR rooms.
 - d. Provide wall elevations of MPOE, ER, MDF, BDF, and IDF/TR rooms at 1/4" scale.
 - e. Provide equipment rack elevations at 1/4" scale.
 - f. Use identical symbols as those used in construction documents.
 - g. Text shall be a minimum of 3/32" high when plotted at full scale.
 - h. Screen all background information.
 - 5. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communication Requirements.

6. Submit Manufacturer's installation instructions.
 7. Complete bill of materials listing all components.
 8. Final test results.
 9. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.05 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communication Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic wiring diagrams.
 5. Telephone numbers for the authorized parts and service distributor.
 6. Include all service bulletins and torque Specifications for all terminations.
 7. Final testing reports.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this section may be used on the Project unless otherwise submitted.
- C. Manufacturer qualifications: Manufacturer must have a minimum 5 continuous years of experience in design and manufacturing of the materials and equipment specified herein.
- D. Installer's qualifications:
1. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide backup supporting information on 5 such Projects.
 2. Installer shall possess a current, active, and valid C7 California State Contractors License, or operate a dedicated C7 division. under a C10 California State Contractors License.
 3. All conduit and power shall be performed by a valid C10 California State Contractors License.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Telecommunication system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipping shall be replaced and returned to Manufacturer at no cost to Owner.

- B. Storage: Store in clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal components damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. OSP fiber and components offered under this Section shall be covered by a minimum 10-year product and application warranty for malfunctions resulting from defects in materials, workmanship and performance as specified by the manufacturer. Warranty shall begin upon acceptance by the owner.
- B. ISP fiber riser and horizontal fiber cable and components offered under this Section shall be covered by a minimum 25-year product and application warranty for malfunctions resulting from defects in materials, workmanship and performance as specified by the manufacturer. Warranty shall begin upon acceptance by the owner.

1.09 MAINTENANCE

- A. Maintenance services:
 - 1. Distributor of the major system components shall maintain a replacement parts department and provide testing equipment when needed. A complete parts department shall be located close enough to supply replacement parts within a 4-hour period.
 - 2. Service must be rendered within 4-hours of system failure notification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The following Manufacturer shall be acceptable and in compliance with the Project scope as specified herein and indicated on the Drawings.
 - 1. Backbone fiber optic cable:
 - a. Corning Cable Systems
 - b. Superior Essex Cable
 - c. BerkTek Cable
 - d. Belden Cabling System
 - e. CommScope
 - f. General Cable
 - 2. Fiber optic terminations:
 - a. Corning Cable Systems
 - b. Ortronics
 - c. Leviton
 - d. Belden Cabling System

- e. CommScope
- f. Panduit
- 3. Indoor Fiber Splice Closure
 - a. Corning Cable Systems
 - b. Ortronics
 - c. Leviton
 - d. Belden Cabling System
 - e. CommScope
 - f. Panduit
- 4. Fiber Splice Trays
 - a. Corning Cable Systems
 - b. Ortronics
 - c. Leviton
 - d. Belden Cabling System
 - e. CommScope
 - f. Panduit
- 5. Innerduct
 - a. MaxCell
 - b. Thomas and Betts
 - c. Carlon
- 6. Test equipment:
 - a. Corning Cable Systems
 - b. Fluke Networks
 - c. Laser Precision
 - d. Tektronix
- B. Substitutions: Under provisions of Section 270010: Basic Communication Requirements.

2.02 OSP BACKBONE FIBER OPTIC CABLE:

- A. Application:
 - 1. Suitable for outdoors installations in underground PVC conduit, where cable protection against water and moisture entry is required.
 - 2. Optical transmission performance is not significantly affected by environmental fluctuations, installation, or aging.
 - 3. Materials do not evolve hydrogen in quantities that will increase light attenuation.
- B. Multimode fiber strands:

1. Minimum physical criteria:
 - a. Core diameter: 50 μ m, $\pm$ 2.5 μ m.
 - b. Cladding diameter: 125 μ m, $\pm$ 1.0 μ m.
 - c. Core/cladding offset: $\leq$ 1.5 μ m.
 - d. Coating diameter: 254 μ m, $\pm$ 7.0 μ m.
 - e. Coating/cladding concentricity: 6.0 μ m.
 - f. Minimum tensile strength: 100,000psi.
 2. Minimum performance criteria:
 - a. Attenuation: 3.0dB/km at 850nm and 1.0dB/km at 1300nm wavelengths, maximum.
 - b. Overfilled bandwidth: 3,000MHz•km at 850nm and 500MHz•km at 1300nm wavelengths, minimum.
 - c. Laser bandwidth: 4,000MHz•km at 850nm and 500MHz•km at 1300nm wavelength, minimum.
- C. Singlemode fiber strands:
1. Minimum physical criteria:
 - a. Core diameter: 8.3 μ m.
 - b. Cladding diameter: 125 μ m, $\pm$ 0.7 μ m.
 - c. Core/cladding offset: $\leq$ 0.5 μ m.
 - d. Coating diameter: 254 μ m, $\pm$ 7.0 μ m.
 - e. Coating/cladding concentricity: 12.0 μ m.
 - f. Minimum tensile strength: 100,000psi.
 2. Minimum performance criteria:
 - a. Attenuation: 0.4dB/km at 1310nm and 0.3dB/km at 1550nm wavelengths, maximum.
 - b. Mode field diameter: 8.4 μ m $\pm$ 0.6 μ m at 1310nm and 8.9 μ m $\pm$ 0.6 μ m at 1550nm.
 - c. Cutoff wavelength: $\leq$ 1260nm.
 - d. Dispersion: 8.0ps/nm•km at 1310nm and 2.6 to 6.0ps/nm•km at 1530 to 1565nm.
- D. Buffering:
1. Fibers shall be loosely buffered, either in a core tube or in multiple tubes around central member.
 2. Buffering tube(s) shall be filled with compound to protect against moisture penetration. Filling compound shall be non-hygroscopic and non-nutritive to fungus ("FLEXGEL," or equivalent). The compound shall be easily removed with conventional nontoxic solvents.-

3. Fibers and buffer tube(s) shall be individually color-coded to meet the requirements of ANSI/TIA/EIA-598-A, also reference ANSI/ICEA S-83-596 and EIA-230.
- E. Cable and sheath:
1. Central member: Dielectric rod (glass-reinforced plastic, GRP).
 2. Fillers (where required to maintain circularity): Plastic rods matched to buffer tube diameter.
 3. Water blocking tape: Applied longitudinally over the central member/buffer tube(s)/filler core.
 4. Strength element: The cable shall have an internal strength element such as aramid yarn.
 5. Rip cord: Nylon or similar (to aid splitting the outer jacket).
 6. Outer jacket: The cable shall have a seamless outer jacket, high or medium density polyethylene or equal, applied to and completely covering the internal components (central member, buffer tube(s), fillers, strength element, etc.). The outer jacket shall contain UV inhibitors for stable performance in direct sunlight. The outer jacket shall be non-hygroscopic and non-nutritive to fungus.
 7. Printing: The jacket shall be printed/permanently marked with the manufacturer, sequential length (feet), fiber type, month and year or quarter and year of manufacture.
- F. Tensile strength: The cable shall have a 600-lbs minimum install rated load and 200-lbs minimum long term rated load.
- G. Operating temperature range: -30-degree C to 75-degree C.
- H. Fiber splice trays:
1. Splice trays shall support 12 to 24 fusion splices.
 2. Trays shall be compatible with the splice closure application and product.
 3. Provide the required quantity of fiber trays and splicing materials as required for a complete system.

2.03 ISP BACKBONE FIBER OPTIC CABLE:

- A. Application:
1. Suitable for indoor installations, between floors exposed in communication equipment rooms as vertical risers, or above suspended ceilings exposed in cable trays, hangers on deck, etc. If space is used as an air plenum, cable shall either be plenum rated or installed in EMT conduit.
 2. Exhibit stable performance in a building environment.
 3. Optical transmission performance is not significantly affected by environmental fluctuations, installation, or aging.
 4. Materials do not evolve hydrogen in quantities that will increase light attenuation.
- B. Multimode fiber strands:

1. Minimum physical criteria:
 - a. Core diameter: 50 μ m, $\pm$ 2.5 μ m.
 - b. Cladding diameter: 125 μ m, $\pm$ 1.0 μ m.
 - c. Core/cladding offset: $\leq$ 1.0 μ m.
 - d. Coating diameter: 254 μ m, $\pm$ 7.0 μ m.
 - e. Coating/cladding concentricity: 8.0 μ m.
 - f. Minimum tensile strength: 100,000psi.
 2. Minimum performance criteria:
 - a. Attenuation: 3.0dB/km at 850nm and 1.0dB/km at 1300nm wavelengths, maximum.
 - b. Overfilled bandwidth: 700MHz•km at 850nm and 500MHz•km at 1300nm wavelengths, minimum.
 - c. Laser bandwidth: 950MHz•km at 850nm and 500MHz•km at 1300nm wavelength, minimum.
- C. Singlemode fiber strands:
1. Minimum physical criteria:
 - a. Core diameter: 8.3 μ m.
 - b. Cladding diameter: 125 μ m, $\pm$ 1.0 μ m.
 - c. Core/cladding offset: $\leq$ 0.5 μ m.
 - d. Coating diameter: 254 μ m, $\pm$ 7.0 μ m.
 - e. Coating/cladding concentricity: 12.0 μ m.
 - f. Minimum tensile strength: 100,000psi.
 2. Minimum performance criteria:
 - a. Attenuation: 0.35dB/km at 1310nm and 0.25dB/km at 1550nm wavelengths, maximum.
 - b. Mode field diameter: 9.2 μ m $\pm$ 0.3 μ m at 1310nm and 10.5 μ m $\pm$ 1.0 μ m at 1550nm.
 - c. Cutoff wavelength: $\leq$ 1260nm.
 - d. Dispersion: 3.2ps/nm•km at 1285 to 1330nm and 18ps/nm•km at 1550nm.
- D. Primary coating:
1. Each fiber shall be completely covered with a “primary coating” (acrylate material).
 2. Coating diameter: 250 μ m, $\pm$ 5 μ m.
- E. Buffering:
1. Each coated fiber shall be fully covered with a material extruded over and directly onto the coating. This shall be the tight buffer.

- a. Tight buffer diameter: 900µm, ±5µm.
- b. Material: PVC or equivalent flame-retardant thermoplastic.
2. Buffer strands shall be individually color-coded to meet the requirements of ANSI/TIA/EIA-598-A, also reference ANSI/ICEA S-83-596 and EIA-230.

F. Cable sheath:

1. Strength element: The cable shall have an internal strength element such as aramid yarn.
2. Outer jacket: The cable shall have a seamless outer jacket, LS-PVC or equal, applied to and completely covering the internal components (fiber strands, strength element, etc.).
3. Tensile strength: The cable shall have a 300-lbs minimum install rated load and a 90-lbs minimum long-term load.
4. Flame rating: OFNP for plenum rated or OFNR for non-plenum riser rated, according to CEC Article 770, tested to NFPA 262 and UL Listed as such.

2.04 BACKBONE FIBER OPTIC TERMINATIONS:

A. Fiber optic patch panels:

1. Patch panels shall be an enclosed housing for protecting, storing, and organizing the termination of fiber cables and fiber strands. Shall also contain facilities to store fiber slack and provide patch cord management.
2. Patch panels shall be passive physical equipment and apparatus used in terminating, interconnecting, and cross-connecting fiber optic cabling. Panel shall possess a minimum fire-resistant rating of UL94V-1 and shall conform to existing OSHA Health and Safety Laws.
3. Patch panels shall come equipped with safety labels such as laser identification or warning labels as required by system considerations.
4. Panels shall be 4U high, 19" rack mountable, accepting up to 12 adapter panels with 12 LC ports in each panel. Panels shall contain rear fiber entry slots, wire retainers and fiber storage drums. Furnish with slide out rails for front access and jumper troughs for cable management. Panels shall be suitable for multimode or singlemode fiber optic cable terminations.
5. Panels shall be provided with LC couplings for termination of fiber optic cables with matching connectors.
6. Provide patch panel and port quantities as required for cable terminations.

B. Fiber optic connectors:

1. Multimode:
 - a. Material:
 - 1) Ferrule ceramic with pre-radiused finish/face.
 - 2) Connector housing: Plastic.

- b. Connector shall have an integral strain relief feature, including a bend limiting rear boot.
 - c. Connector shall be installable via either epoxy or anaerobic method.
 - d. Connector type shall be LC or SC or ST.
 - e. Shall be fusion splice type
- 2. Singlemode:
 - a. Materials:
 - 1) Ferrule ceramic (zirconia or alumina) with pre-radiused finish/face.
 - 2) Connector housing: Plastic.
 - b. Connector shall meet or exceed Ultra PC performance.
 - c. Connector shall have an integral strain relief feature, including a bend limiting rear boot.
 - d. Connector shall be installable via either epoxy or anaerobic method.
 - e. Connector type shall be LC.
 - f. Shall be fusion splice
- C. Fiber optic patch cords:
 - 1. Suitable for indoor installations within communication equipment rooms.
 - 2. Cords shall be factory-assembled from a single, continuous length of cordage, homogenous in nature, and terminated at both ends via connectors as required. Splices are not permitted anywhere.
 - 3. Cordage:
 - a. Conductors: 2 optical conductors/strands, matching physical and optical performance parameters of the singlemode cable plant specified above.
 - b. Construction: Mini Zipcord type with strength member (aramid yarn) and jacket of PVC.
 - c. Flame rating: OFN rated or higher, and UL Listed as such.
 - 4. Connectors:
 - a. Multimode patch cords shall be terminated with either duplex LC connectors at both ends or with duplex LC connectors at one end for connection with the cable plant and via connector type as required for connection to equipment at other end.
 - b. Singlemode patch cords shall be terminated with either duplex LC Ultra PC connectors at both ends or with a duplex LC Ultra PC connector at one end, for connection with the cable plant, and a connector type configured to match the equipment at other end.

2.05 MISCELLANEOUS COMPONENTS

- A. Fiber slack storage rings.
 - 1. Leviton or equal

- a. OSP fiber optic cable: #48900-OFR
 - b. ISP fiber optic cable: #48900-IFR
- B. Velcro cable ties:
 - 1. Width: 0.75" or larger.
 - 2. Color: Same color as the cable to which it is being applied.

2.06 INNERDUCT

2.07 CABLE TESTING EQUIPMENT

- A. Fiber optic light source:
 - 1. Connection interfaces shall be factory installed.
 - 2. Output shall be continuous wavelengths.
 - 3. The light sources may contain internal lenses, pigtails, and modal conditioners, provided they meet the launch conditions as described in "Post-Installation" Passive Link Attenuation Testing Procedures.
 - 4. Laser-based light source for multimode fiber testing shall have the following:
 - a. Center wavelength of 850nm $\pm$ 30nm and 1300nm $\pm$ 20nm
 - b. Special width (FWHM) of $\leq$ 50nm at 850nm and $\leq$ 150nm at 1300nm.
 - c. Minimum output power level of $\geq$ 20dBm.
 - 5. Laser-based light source for singlemode fiber testing shall have the following:
 - a. Center wavelength of 1320nm $\pm$ 20nm and 1550nm $\pm$ 20nm
 - b. Special width (FWHM) of $\leq$ 5nm at 1310nm and $\leq$ 5nm at 1550nm.
 - c. Minimum output power level of $\geq$ 3dBm.
- B. Fiber optic power meter:
 - 1. Power meter for multimode and singlemode testing shall be capable of measuring relative of absolute power (or both) and must be independent of modal distribution.
 - 2. Power meters used must be calibrated and traceable to the National Bureau of Standards.
 - 3. Power meter used shall have the following:
 - a. Dynamic range of 0dBm to -40dBm minimum.
 - b. Accuracy of $\pm$ 0.2dBm.
- C. Fiber optic mandrel:
 - 1. Mandrel diameter for 50/125 μ m jacketed (3.0mm) fiber shall be 22mm.
 - 2. Mandrel diameter for 50/125 μ m unjacketed (0.9mm) fiber shall be 25mm.
- D. Fiber optic OTDR:
 - 1. Multimode source module:

Wavelength	Dynamic Range	Attenuation Deadzone	Reflective Deadzone	Loss Resolution	Distance Accuracy
850nm	24dB	6.5mt	3.0mt	0.001dB	0.1mt
1300nm	27dB	7.0mt	3.0mt	0.001dB	0.1mt

2. Singlemode source module:

Wavelength	Dynamic Range	Attenuation Deadzone	Reflective Deadzone	Loss Resolution	Distance Accuracy
1310nm	40dB	6.0mt	3.5mt	0.001dB	0.1mt
1550nm	28dB	12.0mt	3.5mt	0.001dB	0.1mt

3. Reader software: Windows-based software capable of reading stored traces and is fully functional with the testing equipment.

E. Fiber optic test cords:

1. Multimode fiber optic test cords:

- The fiber of the multimode test cords shall have the core diameter and numerical aperture nominally equal to that of the multimode fiber optic passive link.
- Test cord length for testing insertion loss: 1m to 5m.
- Connectors of the test cords shall be compatible with the connector types of the light source and the power meter, and with the cabling plant.
- The connectors shall exhibit ≤ 0.5 dB loss per connection @ both 850 nm and 1300 nm, as measured per FOTP-171 D2.

2. Singlemode fiber optic test cords:

- The fiber of the singlemode test cords shall have the core diameter and numerical aperture nominally equal to that of the singlemode fiber optic passive link.
- Test cord length for testing insertion loss: 1m to 5m.
- Connectors of the test cords shall be compatible with the connector types of the light source and the power meter, and with the cabling plant.
- The connectors shall exhibit ≤ 0.5 dB loss per connection @ both 1300 nm and 1550 nm, as measured per FOTP-171 D3. The connectors shall inhibit Fresnel reflections (i.e. have a "PC" finish).

PART 3 - EXECUTION

3.01 EXAMINATION

- Contractor shall thoroughly examine Project site conditions for acceptance of the telecommunication fiber optic cabling system installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

- B. Verify that pathways and supporting devices are properly and completely installed prior to cable installation.
- C. Verify dimensions of pathways to include length, i.e. "true tape" conduit runs.
- D. Prior to installation, verify that equipment rooms are ready to accept cables and terminations.

3.02 ISP BACKBONE FIBER OPTIC CABLING

A. Cabling:

1. Cable runs shall have continuous sheath continuity, homogenous in nature, without any splices.
2. Maximum cable length of 1,600-feet (500m) between the terminations at MPOE, ER, MDF, BDF and IDF/TR rooms.
3. Placement:
 - a. Place cables within designated pathways.
 - b. Maintain a minimum bend radius of 20-times the cable diameter during installation and a minimum bending radius of 10-times the cable diameter after installation.
 - c. Maintain pulling tension within manufacturer's limits.
 - d. Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation.
 - e. Do not use cable-pulling compounds for indoor installations.
 - f. Provide 20-feet minimum sheath cable slack at each end of the run within the equipment rooms. Store cable slack in a fiber slack storage ring mounted on wall.
 - g. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of pull rope.
4. Routing:
 - a. Within communication equipment rooms, neatly dress and organize cables on designated cable routing facilities and fasten cables to routing facilities via tie wraps or Velcro type straps.
 - b. When routing horizontally within equipment rooms, utilize the overhead cable runway system. When routing vertically within equipment rooms, utilize the vertical cable support system and provide approved cable straps at 24" intervals.
5. Terminations:
 - a. Properly relieve strain from cables at termination points, at or within the fiber optic termination panels) per manufacturer's instructions.
 - b. Provide breakout kits to furcated fibers from buffer tubes. Provide required accessories and consumables for the complete termination of fiber strands.

- c. Terminate fiber strands at both ends using the specified fiber optic connectors appropriate for the mode type of the fiber. Perform termination in accordance with manufacturer's instructions.
 - d. Provide 3-feet of unsheathed fiber (tight buffer) slack within the patch panel/termination enclosure at each end of the link. Properly store fiber slack in rear of patch panel into the routing rings, per manufacturer's instructions.
- 6. Innerduct
 - a. Provide innerduct and accessories for all conduits containing outside plant fiber optic cables. Innerducts shall consist of 4-1" ducts for each underground and building riser 4" conduit. Install innerduct per manufacturer's instructions. Use pulling equipment and consumables (such as lubricants) allowed by the manufacturer. Place multiple innerduct using pulling harness designed specifically for the use and using pulling swivel.
- B. Termination apparatus:
 - 1. Provide fully assembled termination patch panels in designated equipment racks, located a top of rack. "Fully assembled" includes installation and mounting components and accessories such as adapter panels, coupling adapters, etc. required for operation.
 - 2. Provide accessories required for proper installation of each termination patch panel, including connector panels and adapters.
 - 3. Termination sequence for rack-mount panels: Terminate fiber optic cables first at upper left-most position and all in sequential strand order.

3.03 OSP BACKBONE FIBER OPTIC CABLING:

- A. Innerduct:
 - 1. Provide innerduct and accessories for all conduits containing outside plant fiber optic cables. Innerducts shall consist of 4-1" ducts for each underground and building riser 4" conduit. Install innerduct per manufacturer's instructions. Use pulling equipment and consumables (such as lubricants) allowed by the manufacturer. Place multiple innerduct using pulling harness designed specifically for the use and using pulling swivel.
 - 2. At each vault or pullbox, building entrance and equipment rooms shall secure ducts with 4" plugs, bushings and gaskets as required for a sealed duct.
- B. Cabling:
 - 1. Cable runs shall have continuous sheath continuity, homogenous in nature, between either termination points or designated splice points. Only splices as noted on the Drawings are permitted.
 - 2. Placement:
 - a. Place cables within designated pathways.
 - b. Maintain a minimum bend radius of 20-times the cable diameter during installation and a minimum bend radius of 10-times the cable diameter after installation.

- c. Maintain pulling tension within manufacturer's limits.
- d. Pull cabling using manufacturer specified swivels and harnesses
- e. Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation.
- f. Only use UL approved cable-pulling compounds when necessary to reduce pulling tension.
- g. Provide 20- to 30-feet minimum sheath cable slack at each end of the run within the equipment rooms. Store cable slack in the fiber slack storage ring mounted on wall.
- h. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of pull rope.

3. Routing:

- a. Route cables in innerduct between points of termination throughout entire length, except at the fiber take up reel.
- b. Within equipment rooms, neatly dress and organize cables on designated cable routing facilities and fasten cables to routing facilities via tie wraps or Velcro type straps.
- c. When routing horizontally within communication equipment rooms, utilize the overhead cable runway system. When routing vertically within equipment rooms, utilize the vertical cable support system and provide approved cable straps at 24" intervals.

4. Terminations:

- a. Properly relieve strain from cables at termination points, at or within the fiber optic termination panels, per manufacturer's instructions.
- b. Provide breakout kits to furcated fibers from buffer tubes. Provide required accessories and consumables for the complete termination of fiber strands.
- c. Terminate fiber strands at both ends using the specified fiber optic connectors appropriate for the mode type of the fiber. Perform termination in accordance with manufacturer's instructions.
- d. Provide 3-feet of unsheathed fiber (tight buffer) slack within the patch panel/termination enclosure at each end of the link. Properly store fiber slack in rear of patch panel into the routing rings, per manufacturer's instructions.

C. Termination apparatus:

- 1. Provide fully assembled termination patch panels in designated equipment racks, located a top of rack. "Fully assembled" includes installation and mounting components and accessories such as adapter panels, coupling adapters, etc. required for operation.
- 2. Provide accessories required for proper installation of each termination patch panel, including connector panels and adapters.

3. Termination sequence for rack-mount panels: Terminate fiber optic cables first at upper left-most position and all in sequential strand order.

3.04 FIELD QUALITY CONTROL AND TESTING

A. General:

1. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each days testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
2. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer's discretion, halt testing activity and clean testing equipment, test cords, and related apparatus.
3. Permanently record test results electronically within test equipment at the time of testing.

B. Fiber optic testing:

1. Test fiber optic passive links as follows:

TESTS FOR FIBER OPTIC CABLING TABLE				
Subsystem	Type	Test	Direction	Wavelength
OSP backbone	Multimode	Characterization, passive link insertion loss	Both	850nm and 1300nm
OSP backbone	Singlemode	Characterization, passive link insertion loss	Both	1310nm and 1550nm
ISP backbone	Multimode	Passive link insertion loss	Both	850nm and 1300nm
ISP backbone	Singlemode	Passive link insertion loss	Both	1310nm and 1550nm

2. Precautions:

- a. Adhere to the equipment manufacturer's instructions during testing.
- b. Prior to testing activity or measurements taken, complete the following activities:
 - 1) Ensure the test equipment is at room temperature, approximately 70-degree F.
 - 2) Turn the light source and power meter power on for at least 5-minutes.
 - 3) Clean test/launch cords and system cords, if applicable, connectors and the cabling system adapters with a lint-free wipe and 90 percent (or higher) isopropyl alcohol.
- c. Do not power off OTDR's light source during testing activity.
- d. Do not remove launch cord from the OTDR's light source at any time, unless the testing is complete, or the equipment is being put away for the evening or during trouble shooting.

- e. Do not bend the launch cord smaller than 20-times the cord diameter during testing activities, as this may induce loss into the cord reducing the accuracy of the measurements.

C. Fiber optic characterization testing:

1. Equipment settings/measurement parameters:

- a. Index of refraction, to match cable under test fiber parameters, default settings as follows:

1) Multimode: 1,481 to 1,483 @ 850nm and 1,476 to 1,478 @ 1300nm

2) Singlemode: 1.466 to 1.467 @ 1310nm and 1.467 to 1.4677 @ 1550nm.

- b. Pulse width:

1) Multimode: 4ns for cable lengths up to 980-feet (300m); 20ns for cable lengths between 980-feet (300m) and 6,560-feet (2,000m).

2) Singlemode: 10ns for cable lengths up to 6,560-feet (2,000m); 50ns for cable lengths between 6,560-feet (2,000m) and 32,800-feet (10,000m).

- c. Backscatter:

1) Multimode: -67dB @ 850nm, -74dB @ 1300nm.

2) Singlemode: -74dB @ 1310nm and 1550nm.

- d. Event threshold: 0.05dB.

- e. Reflection threshold:

1) Multimode: -45dB.

2) Singlemode: -60dB.

- f. Fiber break/end-of-fiber: 3dB.

2. Waveform: The waveform shall be real-time and normal density.

3. Obtain measurements using a launch cord connected to the test instrument and the cable under test.

- a. The fiber of the launch cord shall match the fiber of the cable under test in physical and performance parameters (i.e. type, core/cladding size, index of reflection, refraction profile, etc.). The fiber of the launch cord should match the fiber of the cable under test in manufacturer and product.

- b. Use launch cord length between 25- and 100-meters.

D. Fiber optic passive link insertion loss testing:

1. Test cords performance verification:

- a. Connect test cord #1 between the light source and the power meter.

- b. The value displayed on the power meter is the Reference Power (Pref) measurement. If the power meter has a Relative Power Measurement Mode, enter this Pref value into the meter. If it does not, hand-write Pref onto the record document for future reference.

- c. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
- d. Connect the open end of test cord #1 to an adapter of matching connector type. Connect one end of test cord #2 to the adapter and the other end to the power meter.
- e. The value displayed on the power meter is the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the test cord #2 connection attenuation. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the connection attenuation:
 - 1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc.):
Connection attenuation (dB) = ($P_{sum} - P_{ref}$)
 - 2) If P_{sum} and P_{ref} are in watts: Connection attenuation (dB) = $[10 \times \log_{10} (P_{sum}/P_{ref})]$
 - 3) The measured connection attenuation must be less than or equal to the value found in the Table below.
- f. Flip the ends of test cord #2, so that the end connected to the power meter is now connected to the adapter, and the end connected to the adapter is now connected to the power meter.
- g. The meter reading is the reversed P_{sum} . Perform the proper calculations if not using Relative Power Measurement Mode.
- h. Verify that both connection attenuation measurements are less than or equal to the value found in the following Table:

ACCEPTABLE TEST CORD CONNECTION ATTENUATION	
Cable Type	SC (or other Mini-Connector) Cord
Multimode	0.20dB maximum
Singlemode	0.30dB maximum

- i. If both measurements are found to be less than or equal to the values found in the Table, then test cord #1 is acceptable for testing purposes. Unacceptable attenuation measurements may be attributable to test cord #1 or #2. Examine each cord with a portable microscope and clean, polish, or replace, as necessary.
 - j. Repeat this test procedure from the beginning, reversing the test cords in order to verify the performance of test cord #2.
2. Test equipment set-up:
- a. Follow the test equipment manufacturer's initial adjustment and set-up instructions.
 - b. If the meter has a Relative Power Measurement Mode, select this mode.
 - c. If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.

- d. Set the light source and power meter to the same wavelength.
3. Multimode passive link insertion loss testing procedure:
 - a. Determine launch conditions, from the light source as Category 1 per OFSTP-14:
 - 1) General: The launch category of a light source can be determined by measuring its Coupled Power Ratio (CPR). The CPR is a measurement of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation to compensate for a light source's launch characteristic increases the accuracy of the test procedure.
 - 2) Provide two test cords, one for multimode (test cord #1) and one for singlemode (test cord #2). Directly terminate both cords on connectors that are compatible with the light source and power meter.
 - a) The fiber of the multimode test cord shall have a core diameter and numerical aperture nominally equal to those of the permanent link.
 - b) The fiber of the singlemode test cord shall contain Class IVa singlemode fiber with a mode field diameter of $5.0\mu\text{m} \pm 0.5\mu\text{m}$ for 850nm tests and $9.0\mu\text{m} \pm 1.0\mu\text{m}$ for 1300nm tests.
 - 3) Connect the test cord #1 between the light source and the power meter. Avoid placing bends in the cord that are less than 4" in diameter.
 - 4) The meter reading is the Reference Power Measurement (Pref). If the power meter has a Relative Power Measurement Mode, enter the Pref value into the meter. If it does not have this mode, then hand-write the Pref for future reference.
 - 5) Disconnect test cord #1 from the power meter. Do not disconnect test cord from the light source.
 - 6) Connect test cord #2 between the power meter and test cord #1, using an appropriate adapter between the test cords. Test cord #2, the singlemode cord, shall include a high order mode filter. This can be accomplished by twice wrapping the cord around a 1.2" diameter (30mm) mandrel.
 - 7) The meter reading is the Power Measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR. If determined the CPR:
 - a) If Psum and Pref are the same logarithmic units (dBm, dBu, etc.):
$$\text{CPR (dB)} = (\text{Psum} - \text{Pref})$$
 - b) If Psum and Pref are in watts: $\text{CPR (dB)} = [10 \times \log_{10} (\text{Psum}/\text{Pref})]$

COUPLED POWER RATIO (CPR) TABLE					
	CAT-1 Overfilled	CAT-2	CAT-3	CAT-4	CAT-5 Underfilled
850nm Source	20 - 24	16 – 19.9	11 – 15.9	7 – 10.9	0 – 5.9

- b. Test method: Perform the passive link insertion loss testing of multimode fibers according to the “Test Method B: One Jumper Reference,” per OFSTP-14 for permanent links and perform according to the “Test Method C: Three Jumper Reference,” per OFSTP-14 for channel links.
 - 1) After setting up the test equipment and verifying the performance of the test cords and determining the light source’s CPR, the insertion loss of the passive link segments can be measured.
 - 2) Connect test cord #1 between the light source and the power meter.
 - 3) The meter reading is the Pref. If the power meter has a Relative Power Measurement Mode, enter the Pref value into the meter. If it does not have this mode, then hand-write the Pref for future reference.
 - 4) Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
 - 5) Connect test cord #1 to the passive link segment input.
 - 6) At the opposite end of the passive link segment, connect test cord #2 to the link segment input and the power meter.
 - 7) The meter reading is the Psum. If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have this mode, perform the following calculation to determine the insertion loss:
 - a) If Psum and Pref are in the same logarithmic units (dBm, dBu, etc.):
Link segment attenuation (dB) = (Psum - Pref)
 - b) If Psum and Pref are in watts: Link segment attenuation (dB) = $[10 \times \log_{10} (Psum/Pref)]$
 - 8) Record Psum for inclusion into the record documents.
4. Singlemode passive link insertion loss testing procedure:
 - a. Determine the launch conditions:
 - 1) Use the launch conditions as described in FOTP-78.
 - 2) Employ a method to remove high-order propagating modes as described in FOTP-77.
 - b. Test method: Perform the passive link insertion loss testing of singlemode fibers according to the “Test Method A.1: One Jumper Reference,” per OFSTP-7.

- 1) After setting up the test equipment and verifying the performance of the test cords, the insertion loss of the passive link segments can be measured.
 - 2) Connect test cord #1 between the light source and the power meter.
 - 3) The meter reading is the Pref. If the power meter has a Relative Power Measurement Mode, enter the Pref value into the meter. If it does not have this mode, then hand-write the Pref for future reference and to be included in the Record Documents.
 - 4) Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
 - 5) Connect test cord #1 to the passive link segment input.
 - 6) At the opposite end of the passive link segment, connect test cord #2 to the link segment input and the power meter.
 - 7) The meter reading is the Psum. If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have this mode, perform the following calculation to determine the insertion loss:
 - a) If Psum and Pref are in the same logarithmic units (dBm, dBu, etc.):
Link segment attenuation (dB) = (Psum - Pref)
 - b) If Psum and Pref are in watts: Link segment attenuation (dB) = $[10 \times \log_{10} (Psum/Pref)]$
 - 8) Record Psum for inclusion into the record documents.
5. Acceptable measurement values:
- a. Remove and replace any cabling links failing to meet the criteria described in this Specification, at no cost to the Owner, with cables that prove to meet the minimum requirements.
 - b. The general insertion loss equation for any link segment is as follows:
 - 1) Insertion loss = cable loss + connection loss + splice loss + CPR adjustment.
 - 2) Note: A connection is defined as the joint made by two mating fibers terminated with remateable connectors.
 - c. Multimode 50/125µm attenuation coefficients:
 - 1) Cable loss = (Connections x 0.14dB) + 0.24dB.
 - 2) Splice loss = Splice x 0.05dB.
 - 3) CPR adjustment = See Table below:

MULTIMODE LIGHT SOURCE CPR ADJUSTMENT TABLE

	CAT-1	CAT-2	CAT-3	CAT-4	CAT-5

Links w/ LC Connectors	±0.25	0.00	-0.10	-0.20	-0.30

d. Singlemode attenuation coefficients:

- 1) OSP cable loss = Cable length (km) x (0.40dB/km @ 1310nm) or (0.30dB/km @1550nm).
- 2) ISP cable loss = Cable length (km) x (0.650dB/km @ 1310nm) or (0.50dB/km @1550nm).
- 3) Connection loss = (Connection x 0.24dB) + 0.24dB.
- 4) Splice loss = Splices x 0.07dB.
- 5) CPR adjustment = Not applicable for singlemode.

E. Record documents:

1. Permanently record all test results.
2. Export test results' numerical values to a single Microsoft Excel spreadsheet.
3. Submit test results in a format acceptable to the Owner and the Owners Representative before system acceptance.
4. Cable, and fiber identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
5. Measurements shall carry a precision through one significant decimal place, minimum.
6. Use feet for the units for measurements shown on the print of the test measurements.
7. Print report such that fiber strands of a given cabling link have matching axis scales. The "X" and the "Y" axis shall be the same from report-to-report.
8. The trace of the printed test report shall show the launch cord.
9. For each fiber optic backbone cable test, report shall contain the following information:
 - a. Project name and address.
 - b. Test company's and Operator's name.
 - c. Date measurements were taken.
 - d. Test equipment type to include model and serial numbers.
 - e. Cable identification number, fiber/strand number and fiber type.
 - f. Measurement direction.
 - g. Set-up parameters (i.e. wavelength, pulse width, refractive index, event threshold, etc.)
 - h. OTDR trace.
 - i. Length of fiber.

- j. Overall link loss.
- k. Passive link insertion loss testing:
 - 1) Wavelength.
 - 2) Loss measurement.
- 10. For each cabling link, include either a schematic graphic or a brief narrative accurately describing the test set-up. The description shall include test/launch cord (with length), expected events (connectors, slices, etc.) with expected distances, etc. This information will eliminate many questions the Owner's Representative will have while reviewing the reports.
- 11. For each twisted pair backbone and horizontal cable test, report shall contain the following information:
 - a. Project name and address.
 - b. Test company's and Operator's name.
 - c. Date measurements were taken.
 - d. Test equipment type to include model and serial numbers.
 - e. Cable identification number and pair number.
 - f. Measurement results.

3.05 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Owners Representative prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the telecommunication cabling system by this contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.06 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Ensure all fiber optic debris is captured during and post termination of fiber optic cables. Dispose of all fiber optic cabling debris in a container secured from leaks and accidental access.

- E. Clean installed products in accordance with manufacturer's instructions prior to final punchlist.

3.07 TRAINING

- A. At the completion of all Work, a period of not less than 2-hours shall be allocated by the Contractor for instruction and training for the Owner Representative. The Cabling Contractor will need to describe how the cable from each cover plate is separated between different patch panels, how cross-connects are made and other basic cable plant management skills.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 271323

Draft
(Not for Bidding)

SECTION 271500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Horizontal twisted pair cabling.
 - 2. Horizontal cable terminations.
 - 3. Cable testing equipment.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

- 1. Federal Communications Commission (FCC) Regulations:

FCC Part 15; Radio Frequency Devices & Radiation Limits.

FCC Part 68; Connection of Terminal Equipment to the Telephone Network.

- 2. Electronics Industries Alliance (EIA):

EIA 230; Color Marking of Thermoplastic Wire.

- 3. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):

ANSI/TIA/EIA-568-C; Commercial Building Telecommunications Cabling Standards, including the following: Part 1: General Requirements.

Part 2: Balanced Twisted-Pair Cabling Components.

Part 2, Addendum 1: Transmission Performance Specifications for 4-Pair 100 Ohm Category 6A Cable.

TIA SP 3-4426 (12/28/06 or latest version): Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6A Cable (to be published as TIA- 568-C.2-10).

- 4. ANSI/TIA/EIA-569-A; Commercial Building Standard for Telecommunications Pathways and Spaces, including the following:

TIA/EIA-569-A-1: Perimeter Pathway Addendum. TIA/EIA-569-A-2: Furniture Pathway Fill Addendum.

TIA/EIA-569-A-3: Access Floors. TIA/EIA-569-A-4: Poke-Thru Devices.

TIA/EIA-569-A-6: Multi-Tenant Pathway and Spaces. TIA/EIA-569-A-7: Cable Trays and Wireways.

ANSI/TIA/EIA-606-C; Administration Standard for Commercial Telecommunications Infrastructure.

TIA TSB-155; Guidelines for the Assessment and Mitigation of Installed Category 6A Cabling to Support 10GBase-T.

5. Building Industry Consulting Service International, Inc. (BICSI):

BICSI (TDMM); Telecommunication Distribution Methods Manual.

BICSI (WDRM); Wireless Design Reference Manual.

BICSI (NDRM); Network Design Reference Manual.

6. Underwriters Laboratories, Inc. (UL):

UL 444; Communication Cables.

UL 1690; Data-Processing Cable.

UL 1963; Communications-Circuit Accessories.

1.03 SYSTEM DESCRIPTION

A. Provide a complete telecommunication cabling system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:

1. Workstation horizontal twisted pair cabling:

- a. Horizontal twisted pair cables shall route between the IDF/TR and workstation outlets, and shall consist of Category 4-pair, UTP, riser and plenum rated copper cables.
- b. Category horizontal twisted pair cable will support communication devices such as, but not limited to, the following:
 - 1) Data workstations
 - 2) Wireless access points
 - 3) Telephones (VoIP)
 - 4) Emergency phones
 - 5) Fax machines
 - 6) AV equipment
 - 7) HVAC controls
 - 8) Security cameras
 - 9) Security alarm panels
 - 10) Fire alarm system panels
 - 11) Elevator equipment

- 12) Electrical utility meters
- c. Category horizontal twisted pair cables for data system applications shall terminate on modular patch panels for interface with routers/switches.
- d. Horizontal wire management shall be provided above and below each patch panel with 2 RU wire managers.
- 2. Patch cords:
 - a. UTP patch cords shall match the physical and performance criteria of the specified horizontal twisted pair cable from the same manufacturer. The cords shall be terminated with the following:
 - b. Patch cords shall be furnished in varying lengths as required. Coordinate with Owner IT representative. Provide a minimum of two patch cords per data cable.
- B. Refer to Drawings for complete documentation of above requirements and all additional requirements.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 270010: Basic Communications Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment, dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings prepare in Revit, to include the following:
 - a. Building floor plans showing location of all outlets, raceways, cable trays, conduits, and cable routing to each device at same scale as construction documents.
 - b. Provide 1/4" scale plans of equipment layout in MPOE, ER, MDF, BDF, and IDF/TR rooms.
 - c. Provide wall elevations of MPOE, ER, MDF, BDF, and IDF/TR rooms at 1/4" scale.
 - d. Provide equipment rack elevations at 1/4" scale.
 - e. Use identical symbols as those used in construction documents.
 - f. Text shall be a minimum of 3/32" high when plotted at full scale.
 - g. Screen all background information.
 - 5. Furnish structural calculations for equipment anchorage as described in Section 270010: Basic Communications Requirements.
 - 6. Submit Manufacturer's installation instructions.
 - 7. Complete bill of materials listing all components.

8. Final test results.
 9. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.05 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 270010: Basic Communications Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic wiring diagrams.
 5. Telephone numbers for the authorized parts and service distributor.
 6. Include all service bulletins and torque Specifications for all terminations.
 7. Final testing reports.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this section may be used on the Project unless otherwise submitted.
- C. Manufacturer qualifications: Manufacturer must have a minimum 5 continuous years of experience in design and manufacturing of the materials and equipment specified herein.
- D. Installer's qualifications:
1. Installer must have a minimum 5 continuous years of experience in satisfactory completion for Projects similar in scope and cost. Provide backup information on 5 such Projects.
 2. Installer shall possess a current, active, and valid C7 California State Contractors License, or operate a dedicated C7 division. under a C10 California State Contractors License.
 3. Conduit contractor shall possess a current, active, and valid C10 California State Contractors License.
 4. The installer shall be the Manufacturer's certified reseller/installer of the telecommunication equipment/cable system provided. The certification shall have been completed 180 days prior to project bid date. Provide evidence of this certification.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Telecommunication system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by

rainproof material is not acceptable. Equipment damaged during shipping shall be replaced and returned to Manufacturer at no cost to Owner.

- B. Storage: Store in clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal components damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. Units and components offered under this Section shall be covered by a minimum 25-year product and application warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall be provided from the component manufacturer and shall name the owner on the warranty certificate. Warranty shall begin upon acceptance by the Owner.
- B. Contractor shall provide required drawings, test results, application and any other items required by the manufacturer to produce the required warranty.

1.09 MAINTENANCE

- A. Maintenance services:
 - 1. Distributor of the major system components shall maintain a replacement parts department and provide testing equipment when needed. A complete parts department shall be located close enough to supply replacement parts within a 4-hour period.
 - 2. Service must be rendered within 4-hours of system failure notification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Category 6 or 6A horizontal structured cable systems:
 - a. Belden Cabling System
 - b. BerkTek Cable
 - c. CommScope
 - d. General Cable
 - e. Superior Essex Cable
 - 2. Category 6 or 6A twisted pair patch cord cable:
 - a. Belden Cabling System
 - b. CommScope
 - c. Leviton
 - d. Ortronics

- e. Panduit
- 3. Cable test equipment:
 - a. Fluke Networks.
 - b. Agilent Technologies WireScope 350 Test Set.
 - c. Tektronix.
- B. Substitutions: Under provisions of Section 270010: Basic Communication Requirements.

2.02 HORIZONTAL TWISTED PAIR CABLING

A. Horizontal cables:

- 1. Application:
 - a. Suitable for indoor installations, exposed within equipment rooms, above suspended ceilings and below raised floors in cable trays, hangers or on deck, or within walls. If space is used as an air plenum, cable shall either be plenum rated or installed in EMT conduit.
 - b. Each cable run shall be continuous single cable, homogenous in nature, without splices.
 - c. Cables shall meet category cabling performance criteria. Cables shall be CMR or CMP rated as required for rating of space.
- 2. Conductors:
 - a. Eight #23 AWG, solid copper wire insulated with FEP for plenum applications or thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 - b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
- 3. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CMP flame rating according to CEC Chapter 8, tested to NFPA 262 and UL Listed as such.
- 4. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6 or 6A, UTP cabling.
- 5. Refer to construction documents for type and color.

B. Patch Cords:

- 1. Application: Suitable for indoor installations within equipment rooms or workstation environments.
- 2. Cords assembled from a single, continuous length of cordage, homogenous in nature and terminated at both ends via 8-position modular plugs. Splices are not permitted anywhere.
- 3. Cordage:

- a. Eight #23 AWG, solid copper wire insulated with thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 - b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
4. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CM flame rated according to CEC Chapter 8, tested to UL listed as such.
 5. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category UTP cabling.

2.03 HORIZONTAL CABLE TERMINATIONS

A. Category data system patch panels:

1. Terminations of horizontal distribution cable for data and telephone systems shall be made at 2U, 48 port panels.
2. Terminations of horizontal distribution cable for data WAP locations shall be made at 48 port panels.
3. Terminations of horizontal cable for security data locations shall terminate 2U 48 port panels, modular 8-pin connector front for interface with Owner furnished routers/switches via RJ45-RJ45 patch cords. Patch panels shall have 110 type terminations at rear for horizontal cable terminations.
4. Refer to construction documents for type and color.

B. Workstation jacks and coverplates:

1. Outlet coverplates shall be suitable for indoor installations to standard single-gang flush wall mounted outlet box plaster rings and floor boxes.
2. Outlets:
 - a. Data jacks shall be 8-pin, IDC termination.
 - b. Refer to construction documents for type and color.
 - c. Standard wall mounted coverplates:
 - 1) Coverplate shall be single-gang, flush mounted with 4-ports and shall include required accessories.
 - 2) Coverplate shall be white ABS plastic with an ID label window at the top and bottom of the plate.
 - d. Partition furniture mounted coverplates:
 - 1) Coverplates shall have 4-ports and shall include required accessories, such as icons, blank inserts, label windows, and labels.
 - 2) Furniture plate shall match the type furniture installed for a seamless snap in fit to the base knock out of the installed furniture.
 - 3) Coverplates shall match the color of the furniture base.

2.04 MISCELLANEOUS COMPONENTS:

A. Velcro cable ties:

1. Width: 0.75".
2. Color: Velcro cable ties the same color as the cable to which it is applied.

B. Plenum cable ties:

1. Suitable for use in plenums or air handling spaces.
2. Color: Maroon or other distinctive non-white color.

2.05 CABLE TESTING EQUIPMENT

- A. Equipment shall meet TIA/EIA-568-D requirements for Level III accuracy, as applicable for cable type specified herein.
- B. Test standards: ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-Y, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5.
- C. Areas of test measurement (minimum):
 1. Wire Map.
 2. Length.
 3. Insertion Loss.
 4. The following at both master unit and remote unit:
 - a. Near End Crosstalk (NEXT) loss.
 - b. Power Sum NEXT (PSNEXT) loss.
 - c. Equal Level Far End Crosstalk (ELFEXT).
 - d. Power Sum ELFEXT.
 - e. Return Loss (RL).
 - f. Attenuation-to-Crosstalk Ratio (ACR).
 - g. Power Sum ACR (PSACR).
 5. Propagation Delay and Delay Skew.
 6. Characteristic Impedance.
 7. DC Loop Resistance.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the telecommunication cabling system installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.
- B. Verify that pathways and supporting devices are properly and completely installed prior to cable installation.
- C. Verify dimensions of pathways to include length, i.e. "true tape" conduit runs.

- D. Prior to installation, verify that equipment rooms are ready to accept cables and terminations.

3.02 INSTALLATION

A. Horizontal management panels:

1. Provide the horizontal management panels mounted to racks with one above and one below each patch panel.
2. Provide fasteners and parts required to complete the installation.

B. Accessories: Provide all accessories as required for a complete installation. Include one bag of rack mounting screws, as come packaged with rack product. Attach the screws directly to the rack, which shall constitute turn-over to the Owner.

C. Refer to drawings for typical cable types, color, and location quantities.

D. Horizontal twisted pair cabling:

1. Horizontal cable installation and routing:

- a. Cable runs shall have continuous sheath continuity, homogenous in nature with no splicing.
- b. Cabling shall not exceed a cable length of 295' (90m) from the termination point at the Telecom room to the termination at the workstation outlet, including service slack, when measured using test equipment. The cable length shall be determined by the contractor prior to installing cable with a true tape. Cable lengths exceeding the 295-foot maximum length, shall be brought to the attention of the engineer of record (EOR).
- c. Place cables within the designated pathways, such as cable tray or basket tray, cable runway, cable hangers, etc. Do not fasten, support or attach cables to other building infrastructures (i.e. ducts, pipes, conduits, etc.), other systems (i.e. ceiling support wires, wall studs, etc.), or to the outside of conduits, cable trays and non-approved pathway systems.
- d. Place and suspend cables during installation and termination in a manner to protect them from physical damage or interference. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
- e. Route cables at 90-degree angles, allowing for bending radius.
- f. Do not exceed pulling tension of 25-lbs.
- g. Do not use cable-pulling compounds.
- h. Do not exceed a minimum bend radius of 6 times the cable diameter during and after installation.
- i. Route cables beneath other building infrastructures (i.e. ducts, pipes, conduits, etc.) in above ceiling applications. Do not route cables over building infrastructure/s. The installation shall result in easy accessibility to the cables in the future.
- j. Place cables 6" minimum away from power sources to reduce interference from EMI.

- k. Do not set 360-degree service loops in place for slack storage. Instead, set slack as forward-and-back or as figure eights.
 - l. Place a pull string along with cables where run in conduits and spare capacity in conduit remains. Tie off ends of the pull string to prevent the string from falling onto the conduit.
 - m. When exiting the primary pathway, such as cable or basket tray, to the workstation outlets, exit via the top of the pathway. Secure the cables to the pathway using an approved Velcro cable tie.
2. Cable routing and dressing within telecommunications rooms:
- a. Within rooms, only use Velcro type straps on bundles.
 - b. Individual bundles of cable shall not exceed 48 cables to minimize heating of cables that use PoE. Bundles of cables shall be per 48-port patch panel.
 - c. Place cables within the overhead cable support system. When routing vertically on walls, fasten the cables onto vertical supports every 24" on center.
 - d. Provide 12" minimum sheath cable slack, length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support system.
 - e. At the rack bay, route, and neatly dress cables from the overhead cable support system into the back of the vertical management sections. Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. Fasten the cables to the cable support bar at the back of the patch panel using approved ties.
3. Termination in the telecommunications rooms:
- a. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories, and associated management apparatus according to the manufacturer's instructions.
 - b. Properly relieve strain from the cables to and at termination points per manufacturer's instructions. Provide a strain relief bar at the back of the modular patch panels for proper strain relief.
 - c. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and TIA/EIA-568-R standard installation practices.
 - d. Modular patch panels and horizontal management panels:
 - 1) Provide quantity of patch panels to support the terminations of cables served from respective Telecom Room.
 - 2) Install and assemble patch panels and wire management panels according to the manufacturer's instructions.
 - 3) Install the termination hardware and cable management as shown on the Drawings.

- 4) Terminate cables in sequential order using the link's identifier starting at the top left and completing a block before moving to the next block below.
 - 5) Terminate all WAP cables on patch panel, separate from all other horizontal and backbone cabling.
4. Cable routing and dressing at workstations:
- a. Provide 18" cable slack at each workstation outlet, length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger or other approved cable support device.
 - b. Route to partition furniture mounted faceplates:
 - 1) Route cables from primary or secondary pathway within ceiling through the furniture partition feed pathway (stub from wall or floor box) into opening at bottom of furniture system. Exercise caution to prevent scraping, cutting or other damage to cable jacket.
 - 2) Provide spiral wrap around cables from furniture-feed pathway to point where cables enter furniture.
5. Termination at the workstation outlets:
- a. Provide device components, connectors, and accessories required for a complete installation. Install and assemble connectors, jacks, adapters, termination apparatus, accessories, and associated management apparatus according to the manufacturer's instructions.
 - b. Refer to drawings for color, type and quantity of wall mounted standard devices:
 - 1) Install devices at heights indicated on drawings.
 - 2) Mount faceplates plumb, square and at the same level as adjacent power receptacles.
 - 3) Patch gaps around faceplates so that faceplate covers the entire wall opening.
 - c. Partition furniture mounted devices:
 - 1) Coordinate installation of the faceplate adapters with the furniture contractor, including color.
 - 2) Mount faceplate adapters into the designated openings for horizontal cables.
 - d. Terminate cables and twisted pairs in accordance with the manufacturer's latest installation requirements and TIA/EIA-568-D standard installation practices. Terminate cable pairs onto the connector compliant to T568 wiring standards.
6. Patching and cross connecting:
- a. In equipment rooms, provide one modular patch cord for each connector jack in each workstation outlet. Install from the horizontal termination field to the network switches/equipment. Neatly dress patch cords within the horizontal and vertical cable management components. Cord lengths shall be coordinated with the Owners IT representative.

- b. At workstations, provide one modular patch cord for each cable jack installed in each workstation outlet. Cord lengths shall be 10' or length as coordinated with Owner, and each shall be labeled.

E. General requirements:

1. Labeling, label colors, and identifier assignments shall conform to EIA/EIA-606-D Administration Standards and as approved by the Owner.
2. Provide permanent and machine-generated labels. Handwritten labels will not be accepted.

F. Mounting:

1. Wireless access points
 - a. Two-gang cover plate with 2-ports when wall mounted.
 - b. 4-11/16" square surface mount box for above ceiling attached to #12 AWG steel wire or wall.
2. Surveillance camera outlets
 - a. 4-11/16" square surface mount box for above ceiling attached to #12 AWG steel wire or wall.
 - b. One-gang ring when wall mounted.
3. Wall mounted telephone
 - a. Single-gang metal coverplate with 1-port and two support studs.

G. Specialty:

1. Specialty analog telephone (fire alarm system panel, security panel, elevator phones, etc.) outlets shall consist of the following, unless otherwise noted on the Drawings:
2. Two horizontal twisted pair cable per outlet.
3. Two port surface mount box (SMB) mounted in enclosure.
4. Two RJ-45 connector jacks for twisted pair terminations

H. Horizontal twisted pair labeling:

1. Labeling shall be per Section 270553 or the Owners standards. Coordinate with the Owners IT representative prior to the labeling phase of the cable installation to determine the Owners labeling requirements.
2. Cables:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) Provide labels on both ends of cable.
 - 2) Install labels such that they are visible by technician from a normal stance.
 - 3) Fully wrap label around the cable jacket (self-lamination).
 - 4) Provide one label within 4" of the termination apparatus.

3. Modular patch panels:
 - a. Text color shall be black, #10 font size.
 - b. Label installation: Provide a Letter designation for each panel (A, B, C etc.). Patch Panel port number will match the cable designation at the station end.
4. Outlets:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) At faceplates, provide labels above and below jacks.
 - 2) At surface boxes, provide labels on the top of the box.

3.03 FIELD QUALITY CONTROL AND TESTING

A. General:

1. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
2. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer's discretion, halt testing activity and clean testing equipment, test cords and related apparatus.
3. Permanently record test results electronically within test equipment at the time of testing.

B. Twisted pair testing:

1. Test for UTP cabling as follows:

TESTS FOR CATEGORY 6 CABLING TABLE				
Subsystem	Type	Test	Configuration	Notes
Horizontal	Category 6A	Category 6A	Permanent Link	Per TIA/EIA-568-C.2

2. Precautions:
 - a. Adhere to the equipment manufacturer's instructions during all testing.
 - b. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature, approximately 70-degrees F.
 - c. Fully charge power sources before each day's testing activity.
3. Horizontal twisted pair testing:
 - a. Test equipment set-up:
 - 1) Set-up the tester to perform a full Category 6A test, as a Permanent Link configuration.
 - 2) If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6A cable.
 - 3) Set the tester to save the full test results (all test points, graphs, etc.).
 - 4) Save the test results with associated cable link identifier.

5) Calibrate the test set per the manufacturer's instructions.

b. Acceptable test results measurements:

1) Overall test results:

- a) Links which report a Fail, Fail or Pass for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
- b) Any reconfiguration of link components required because of a test Fail, must be re-tested for conformance.
- c) Remove and replace any cabling links failing to meet the criteria described in this Specification, at no cost to the Owner, with cables that prove to meet the minimum requirements.

2) Wire map: Provide continuous pairs and terminate all the cabling links correctly at both ends, no exceptions taken.

3) Length: One hundred meters (328 feet) is the maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration, including test cords.

4) Insertion loss: The acceptable insertion loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.

5) Worst pair-to-pair near end crosstalk (NEXT) loss: The acceptable worst pair-to-pair NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.

6) Power sum NEXT loss: The acceptable power sum PS-NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.

7) Worst pair-to-pair ELFEXT and FEXT loss: The acceptable worst pair-to-pair ELFEXT and FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.

8) Power sum ELFEXT and FEXT loss: The acceptable PS-ELFEXT and PS-FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.

9) Return loss: The acceptable return loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.

10) Propagation delay and delay skew: The acceptable propagation delay and delay skew measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.

c. Record documents:

- 1. Permanently record all test results.
- 2. Export test results' numerical values to a single Microsoft Excel spreadsheet.
- 3. Submit test results in a format acceptable to the Owner, Owner's Representative, and the Engineer before system acceptance.

4. Cable and pair identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
5. Measurements shall carry a precision through one significant decimal place, minimum.
6. Use feet for the units for measurements shown on the print of the test measurements.
7. Print report such that fiber strands of a given cabling link have matching axis scales. The "X" and the "Y" axis shall be the same from report-to-report.
8. The trace of the printed test report shall show the launch cord.
9. For each cabling link, include either a schematic graphic or a brief narrative accurately describing the test set-up. The description shall include test/launch cord (with length), expected events (connectors, slices, etc.) with expected distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.
10. For each twisted pair horizontal cable test, report shall contain the following information:
 - a. Project name and address.
 - b. Test company's and Operator's name.
 - c. Date measurements were taken.
 - d. Test equipment type to include model and serial numbers.
 - e. Cable identification number and pair number.
 - f. Measurement results.
 - g. Pass/Fail

3.04 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Engineer prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the telecommunication cabling system by this contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.05 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.

- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Clean installed products in accordance with manufacturer's instructions prior to final punch list.

3.06 TRAINING

- A. At the completion of all Work, a period of not less than 2-hours shall be allocated by the Contractor for instruction and training for the Owner's Representative. The Cabling Contractor will need to describe how the cable from each cover plate is separated between different patch panels and 110 blocks, how cross-connects are made and other basic cable plant management skills.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 271500

SECTION 280010

BASIC ELECTRONIC SAFETY AND SECURITY REQUIREMENTS PART 1 - GENERAL

1.01 SUMMARY

A. Table of Contents, Division 28 – Electronic Safety and Security:

<u>SECTION NO.</u>	<u>SECTION TITLE</u>
280010	BASIC ELECTRONIC SAFETY & SECURITY REQUIREMENTS
280513	ELECTRONIC SAFETY & SECURITY CONDUCTORS &
CABLES	
280528	ELECTRONIC SAFETY & SECURITY PATHWAYS
280529	ELECTRONIC SAFETY & SECURITY HANGERS & SUPPORTS
280553	ELECTRONIC SAFETY & SECURITY IDENTIFICATION
280800	ELECTRONIC SAFETY & SECURITY COMMISSIONING
281300	SECURITY ACCESS CONTROL SYSTEM
281600	SECURITY INTRUSION DETECTION SYSTEM
282300	SECURITY VIDEO SURVEILLANCE SYSTEM
283100	FIRE ALARM SYSTEM

B. Work included: This Section includes general administrative and procedural requirements for Division 28. The following administrative and procedural requirements are included in this Section to supplement the requirements specified in Division 01.

1. Quality assurance.
2. Definition of terms.
3. Submittals.
4. Coordination.
5. Record documents.
6. Operation and maintenance manuals.
7. Rough-in.
8. Installation.
9. Cutting, patching, painting, and sealing.
10. Field quality control.
11. Cleaning.
12. Project closeout.

C. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete and operable installation.

1. General and supplementary conditions: Drawings and general provisions of Contract and Division 01 of the Specifications, apply to all Division 28 Sections.

2. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, etc. Refer to Division 31, Earthwork.
 3. Concrete Work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, pull box slabs, vaults, etc. Refer to Division 03, Concrete.
 4. Miscellaneous metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, cable trays, racks, etc. Refer to Division 05, Miscellaneous Metals.
 5. Miscellaneous lumber and framing Work: Include wood grounds, nailers, blocking, fasteners and anchorage for support of electronic safety and security materials and equipment. Refer to Division 06, Rough Carpentry.
 6. Moisture protection and smoke barrier penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vaportight. Refer to Division 07, Thermal and Moisture Protection.
 7. Access panels and doors: Required in walls, ceilings, and floors to provide access to electronic safety and security devices and equipment. Refer to Division 08, Access Doors also, Division 05, Metals.
 8. Painting: Include surface preparation, priming and finish coating as required for exposed conduit, pull and junction boxes, etc. where indicated as field painted in this Division. Refer to Division 09, Painting.
 9. Conduit, boxes, wiring, and support: Include conduit and boxes for Interbuilding and Intrabuilding distribution of cabling. Refer to Division 26: Electrical.
- D. Work furnished and installed under another Division requiring connections or interface under this Division includes but is not limited to:
1. Elevator controllers
 2. Mechanical BAS control panel
 3. Communication system

1.02 QUALITY ASSURANCE

- A. Reference to Codes, Standards, Specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow Work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements, or extent of the Contract Documents. The Contract Documents address the minimum requirements for construction.

- C. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
1. California Electrical Code (CEC).
 2. California Building Code (CBC).
 3. California Fire Code (CFC).
 4. California Mechanical Code (CMC).
 5. FCC Regulations, Part 15 – Radio Frequency Devices & Radiation Limits.
- D. Standards: Equipment and materials specified under this Division shall conform to the following standards where applicable:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
BICSI	Building Industry Consulting Service International, Inc
EIA	Electronics Industries Alliance
FCC	Federal Communications Commission
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
TIA	Telecommunication Industry Association
UL	Underwriters' Laboratories

1.03 DEFINITIONS

- A. The definitions of Division 01 shall apply to this Division of Work.
- B. In addition to those definitions of Division 01, the following list of terms as used in this specification shall be defined as follows:
1. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.
 2. Install: To set in place, join, unite, fasten, link, attach, set up or otherwise connect, and test before turning over to the Owner, all parts, items, or equipment supplied by contractor. Installation shall be complete and ready for regular operation.
 3. Provide: To furnish, transport, install, erect, connect, test, and turn over to the Owner, complete and ready for regular operation.
 4. Connect: To install all required patch cords, equipment cords, cross-connect wire, device, and appliance wiring, etc. to complete system conductivity.
 5. As directed: As instructed by the Owner, or their authorized representative.
 6. Cabling: A combination of all cables, wire, cords, and connecting hardware, e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling.
- C. Abbreviations:
1. ACS: Access Control System

2. AFF: Above Finish Floor. Standard mounting height (e.g. 18" AFF) for a device using the center line of the device as the measurement point.
3. CCTV: Closed-Circuit Television. A private television system, typically used for security purposes, in which the signal is transmitted to a limited number of receivers.
4. VSS: Video Surveillance System

1.04 SUBMITTALS

- A. Format: Furnish submittal data in electronic (.pdf) format for each Specification Section with a table of contents listing materials by Section and paragraph number.
- B. Source and Quality: Submittals shall be generated directly from the manufacturer's electronic documentation and shall maintain full text searchability. Scanned, photocopied, or otherwise non-searchable documents will not be accepted.
- C. Legibility: All submitted documents shall be of high resolution, clearly legible, and free from distortions, artifacts, or other quality deficiencies that could impair readability.
- D. Submittals shall consist of detailed Shop Drawings, Specifications, block wiring diagrams, "catalog cuts" and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication and material finish. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded. Furnish quantities of each submittal as noted in Division 01.
- E. Each submittal shall be labeled with the Specification Section Number and shall be accompanied by a cover letter or shall bear a stamp stating that the submittal has been thoroughly reviewed by the Contractor and is in full compliance with the requirements of the Contract Documents or provide a Specification Section line-by-line compliance response statement with detailed exception/ deviation response statements for all applicable provisions for the applicable Specification Section. Any Specification Section lines without a detailed exception/ deviation response statement shall be treated as the Contractor or Vendor is submitting in full compliance with the applicable Specification Section requirements. Cover letters shall list in full the items and data submitted. Failure to comply with this requirement shall constitute grounds for rejection of data.
- F. The Contractor shall submit detailed Drawings of all electronic safety and security equipment rooms and closets if the proposed installation layout differs from the construction documents. Physical size of electronic safety and security equipment indicated on the Drawings shall match those of the electronic safety and security equipment that is being submitted for review, i.e.: equipment racks, cabinets, etc. Minimum scale: 1/4" = 1'- 0". Revised electronic safety and security equipment layouts must be approved prior to release of order for equipment and prior to installation.
- G. As part of the equipment submittals, the Contractor shall provide anchorage calculations for floor and wall mounted electronic safety and security equipment, conduits, and raceways, in conformance with the latest edition of the California Building Code (CBC) and ASCE 7. Use the Occupancy Category, Ground Accelerations, Site Class, Seismic Design Category, and Seismic Importance Factor

as noted in the structural drawings. For components required for Life Safety or containing hazardous materials use $I_p=1.5$. Structural Calculations shall be prepared, stamped, and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

- H. The Manufacturer shall recommend the method of anchoring the equipment to the mounting surface and shall provide the Contractor with the assembly dimensions, weights, and approximate centers of gravity.
- I. Review of submittals is for general conformance to design concept and general compliance with the Specification Sections. Submittal Review Comments do not imply waiver of Specifications Section requirements unless specifically noted.
- J. All re-submittals shall include a cover letter that lists the action taken and revisions made to each Drawing and equipment data sheet in response to Submittal Review Comments. Re-submittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.
- K. Substitutions:
 - 1. All requests for substitutions shall conform to the general requirements and procedure outlined in Division 01.
 - 2. Where items are noted as "or equal," a product of equal design, construction and performance will be considered. Contractor must submit to the Engineer all pertinent test data, catalog cuts and product information required substantiating that the product is in fact equal to that specified. Only one substitution will be considered for each product specified.
 - 3. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility, and appearance. Materials, processes, or equipment, which in the opinion of the Engineer is equal in quality, utility and appearance will be approved as substitutions to that specified.
 - 4. Whenever any material, process or equipment is specified in accordance with a ASTM standard, an ANSI specification, UL rating or other association standard, the Contractor shall present an affidavit from the Manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, support test data to substantiate compliance shall be submitted by the Contractor at no additional cost.
 - 5. Substitutions shall be equal, in the opinion of the Architect/Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Architect/Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted article or material to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work or from any provisions of the Specifications.
 - 6. The Contractor shall be responsible for all expenses in connection with the substitution materials, processes, and equipment, including the effect of the substitution on the Contractor, Subcontractor's, or other Contractor's Work. No substitution of material, processes or equipment shall be permitted without

written authorization of the Architect/Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.

1.05 COORDINATION

A. Discrepancies:

1. In the event of discrepancies within the Contract Documents, the Engineer shall be so notified, within sufficient time, as delineated in Division 01, prior to the Bid Opening to allow the issuance of an Addendum.
2. If, in the event that time does not permit notification or clarification of discrepancies prior to the Bid Opening, the following shall apply: The Drawings govern in matters of quantity and the Specifications govern in matters of quality. In the event of conflict within the Drawings involving quantities or within the Specifications involving quantities or within the Specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Contractor's Bid. No additional allowances will be made because of errors, ambiguities or omissions that reasonably should have been discovered during the preparation of the Bid.

B. Project conditions:

1. Examination of Project site: The Contractor shall visit the Project site and thoroughly review the locale, working conditions, conflicting utilities, and the conditions in which the electronic safety and security Work will take place. Verify all existing conditions in the field. No allowances will be made subsequently for any costs that may be incurred because of any error or omission due to failure to examine the Project site and to notify the Engineer of any discrepancies between Contract Documents and actual Project site conditions.
2. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover equipment, devices, and apparatus and protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition any fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.
3. Supervision: Contractor shall personally or through an authorized and competent representative constantly supervise the Work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.

C. Drawing preparation:

1. Layout: General layout indicated on the Drawings shall be followed except where other Work may conflict with the Drawings.
2. Accuracy: Drawings for the Work under this Section are essentially diagrammatic within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation required for the electronic safety and security systems. Drawings indicate the layout and locations of major equipment components, as well as field devices and

appliances, but do not show all conduits between equipment, components, devices, and appliances.

1.06 RECORD DOCUMENTS

A. Provide Project Record Drawings as described herein:

1. Drawings shall fully represent installed conditions including actual locations of electronic safety and security equipment, labeling of all components and systems, correct conduit and cabling as well as routing, revised schedule listing Manufacturers and products installed. Contractor shall record all changes in the Work during the course of construction on black line prints. These prints shall be made subject of monthly review by the Owner's Representative to ascertain that they are current. If not, current monthly payments may be withheld.
2. Record drawing submissions shall be provided to the Engineer to review upon the completion of the following phases of Work:
 - a. All underground installation.
 - b. Building electronic safety and security rough-in.
 - c. Final electronic safety and security installation.
3. A single set of half size prints of the Record Drawings shall be submitted for review. Upon receipt of the Engineer's review comments, corrections shall be made, and the Contractor shall provide the following:
 - a. One electronic file of Revit
 - b. One electronic set in pdf.

1.07 OPERATION AND MAINTENANCE MANUALS

- ##### A. Prior to Project closeout furnish to the Owner, six (6) hard back 3-ring binders containing all bulletins, operation and maintenance instructions, part lists, service telephone numbers and other pertinent information as noted in each Section all equipment furnished under Division 28. Binders shall be indexed into Division Sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 ROUGH-IN

- ##### A. Contractor shall verify lines, levels and dimensions indicated on the Drawings and shall be responsible for the accuracy of the setting out of Work and for its strict conformance with existing conditions at the Project site.
- ##### B. Verify final locations for rough-in with field measurements and with the requirements for the actual equipment to be connected.

3.02 INSTALLATION

- ##### A. Preparation, sequencing, handling, and installation shall be in accordance with Manufacturer's written instructions and technical data particular to the product specified and/or accepted equal, except as otherwise specified. Refer to Shop Drawings prepared by Manufacturer.

- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electronic safety and security installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate and integrate installations of electronic safety and security materials and equipment for efficient flow of the Work. Give attention to large equipment requiring positioning prior to closing in the building.
- F. Where mounting height is not detailed or dimensioned, contact the Architect for direction prior to proceeding with rough-in.
- G. Coordinate connection of electronic safety and security systems with exterior underground utilities and services. Comply with requirements of governing regulations and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are indicated only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- I. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install electronic safety and security equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Coordinate electronic safety and security systems, equipment, and materials installations with other building components.
- L. Provide access panel or doors where devices or equipment are concealed behind finished surfaces. Furnish and install access doors per the requirements of Division 08.
- M. Install systems, materials and equipment giving right-of-way priority to other systems that are required to maintain a specified slope.

3.03 CUTTING, PATCHING, PAINTING AND SEALING

- A. Structural members shall in no case be drilled, bored, or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect and Structural Engineer.
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- C. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

- E. Patch existing surfaces and building components using experienced installers and new materials matching existing materials and the original installation. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.
- F. Application of joint sealers:
 - 1. General: Comply with joint sealer Manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 2. Installation of fire-stopping sealant: Install sealant, including forming, packing and other accessory materials, to fill openings around electronic safety and security penetrating floors and walls, to provide firestop and fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.04 FIELD QUALITY CONTROL

- A. General testing requirements:
 - 1. The purpose of testing is to ensure that all tested electronic safety and security equipment, both Contractor and Owner supplied, is operational and within industry and Manufacturer's tolerances and is installed in accordance with design Specifications.
 - 2. Tests and inspections shall determine suitability for energization.
 - 3. Perform tests in presence of the Owner's Representative and furnish test equipment, facilities and technical personnel required to perform tests.
 - 4. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.
- B. Testing safety and precautions shall include the following requirements:
 - 1. Applicable State and Local safety operating procedures.
 - 2. OSHA.
 - 3. NSC.
 - 4. NFPA 70E.
- C. Coordinate with General Contractor regarding testing schedule and availability of equipment ready for testing.
- D. Notify Owner and Engineer one week in advance of any testing.
- E. Any products which fail during the tests or are ruled unsatisfactory by the Owner's Representative shall be replaced, repaired, or corrected as prescribed by the Owner's Representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.
- F. Testing Agency shall maintain written record of tests and shall assemble and certify final test report.
- G. Include all test results in the maintenance manuals.

3.05 CLEANING

- A. Prior to acceptance of electronic safety and security systems, the Contractor shall thoroughly clean electronic safety and security rooms from construction debris, scrap wire, etc. using Manufacturer's approved methods and materials.
- B. Upon completion of Project, prior to final acceptance, the Contractor shall thoroughly clean both the interior and exterior of all electronic safety and security equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- C. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

3.06 PROJECT CLOSEOUT

- A. Training: At the time of completion, a period of not less than 2-hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 2-hours training is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with Manufacturer's Representative. The equipment Manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.
- B. Special tools: Provide one of each tool required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.
- C. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF SECTION 280010

SECTION 280513

ELECTRONIC SAFETY & SECURITY CONDUCTORS & CABLES PART 1 -

GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conductors.
 - 2. Cables.
 - 3. Wiring connections and terminations.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute, Inc. (ANSI) / Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):

ANSI/TIA/EIA-568-C; Commercial Building Telecommunications Cabling Standards, including the following: Part 1: General Requirements.

Part 2: Balanced Twisted-Pair Cabling Components.

Part 2, Addendum 1: Transmission Performance Specifications for 4-Pair 100 Ohm Category 6A Cable.

TIA SP 3-4426 (12/28/06 or latest version): Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6A Cable (to be published as TIA- 568-C.2-10).

ANSI/TIA/EIA-606-C; Administration Standard for Commercial Telecommunications Infrastructure.

TIA TSB-155; Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBase-T.

- 2. Institute of Electrical and Electronic Engineers (IEEE):

IEEE 82; Test Procedure for Impulse Voltage Tests on Insulated Conductors.

IEEE 576; Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.

3. National Electrical Manufacturer Association (NEMA):

NEMA WC-5; Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

NEMA WC-7; Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

4. Underwriters Laboratories, Inc. (UL):

UL 44; Thermoset-Insulated Wires and Cables.

UL 83; Thermoplastic-Insulated Wires and Cables.

UL 310; Electrical Quick-Connect Terminals.

UL 444; Communication Cables.

UL 486A & B; Wire Connectors.

UL 486C; Splicing Wire Connectors.

UL 486D; Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

UL 493; Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables.

UL 1581; Reference Standard for Electrical Wires, Cables and Flexible Cords.

UL 1690; Data-Processing Cable.

UL 1963; Communications-Circuit Accessories.

UL 2196; Standard for Tests of Fire Resistive Cables.

1.03 SYSTEM DESCRIPTION

A. Provide a complete electronic safety and security conductor and cable system installation as specified herein and as shown on the Drawings. In general, system shall include, but not be limited to, the following:

1. Provide all required conductor and cable supports for complete installation as specified.
2. Provide required conductor and cable sizes to allow for voltage drop on long runs.
3. Provide for effective shielding to allow the routing of 12 to 24 volt power and video conductors and cables in the same conduit without interference or signal noise.
4. Conductors and cables installed outdoors and in underground conduits, shall meet all CEC requirements and be rated for exterior applications.
5. Cables installed indoors, not in conduit, shall require a plenum-rated jacket (type CMP).

B. Conductor and cable sizing:

1. 24 volt DC or AC locks: 2-conductor, #18 AWG, stranded, unshielded.
2. Motion detector: 2-twisted pair, #22 AWG, stranded, unshielded.
3. Glass break detector: 2-twisted pair, #22 AWG, stranded, unshielded.
4. Door alarm contact: 2-twisted pair, #18 AWG, stranded, unshielded.
5. Card reader: 8-conductor, #18 AWG, stranded, unshielded.
6. Ethernet network: Category 6A.
7. Camera (PoE): Category 6A.
8. Cabinet hook-up: 600 volt MTW (TFF or AWM), #18 AWG, stranded, unshielded.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - a. Building floor plans showing location of all equipment, devices, appliances, raceways, conduits, and cable routing to each device at same scale as construction documents.
 - b. Provide 1/4" scale plans of equipment layouts.
 - c. Provide wall elevations of equipment layouts at 1/4" scale.
 - d. Provide equipment rack elevations at 1/4" scale.
 - e. Use identical symbols as those used in construction documents.
 - f. Text shall be a minimum of 3/32" high when plotted at full scale.
 - g. Screen all background information.
 3. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 4. Submit Manufacturer's installation instructions.
 5. Complete bill of materials listing all components.
 6. Final test results.
 7. Warranty.
- B. Dimensions and configurations of equipment shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout, if equipment furnished varies in size from that indicated on Drawings, for approval.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. Independent Testing Agency qualifications: Refer to Section 280010: Basic Electronic Safety & Security Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Building wire:
 - a. Belden Cabling System.
 - b. General Cable
 - c. West Penn
 - d. Belden Cabling System
 - e. BerkTek Cable
 - f. CommScope
 - g. General Cable
 - h. Superior Essex Cable
 - 2. Wiring connectors and terminations:
 - a. 3M Company.
 - b. Ideal.
 - c. Blackburn-Holub.
 - d. Burndy.
 - e. Thomas & Betts Corp.
 - f. Beau Barrier.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 CONDUCTORS

- A. Conductor material:
 - 1. Provide annealed copper for all conductors.
 - 2. Copper wire AWG #12 and smaller may be solid or stranded as best suited for the installation or as specified herein.
- B. Insulation material:
 - 1. All insulated wire, conductor and cable shall be 600 volt rated, unless otherwise noted on the Drawings.

2. Thermoplastic-insulated building wire: NEMA WC 5.
3. Copper conductors #8 AWG and smaller: Type TW, THW, XHHW or dual rated THHN/THWN.
4. Hook-up conductors #8 AWG and smaller: Type MTW, TFF or AWM.
5. Identify system conductors as to voltage and phase connections by means of color-impregnated insulation.

2.03 CABLES

A. Horizontal twisted-pair cables:

1. Application:
 - a. Each cable run shall be continuous single cable, homogenous in nature, without splices.
 - b. Cables shall meet 6A performance criteria.
 - c. Cables shall be CMR or CMP rated as required for rating of space.
2. Conductors:
 - a. Eight #23 AWG, solid copper wire insulated with FEP for plenum applications or thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.
 - b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
3. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CMP flame rating according to CEC Chapter 8, tested to NFPA 262 and UL Listed as such.
4. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6A, UTP cabling.
5. Color: Cable shall be blue in color.

B. Twisted-pair patch cords:

1. Application: Suitable for indoor installations within equipment room environments.
2. Cords assembled from a single, continuous length of cordage, homogenous in nature and terminated at both ends via 8-position modular plugs. Splices are not permitted anywhere.
3. Cordage:
 - a. Eight #23 AWG, solid copper wire insulated with thermoplastic polyethylene or high-density polyolefin for non-plenum rated applications.

- b. Two insulated conductors twisted together to form a pair and four such paired cables to form a unit with individually color-coded pairs to conform to industry standards (ANSI/ICEA Publication S-80-576-1994 and EIA-230).
- 4. Cable sheath:
 - a. Seamless outer jacket, flame-retardant PVC, applied to and completely covering the internal components (twisted pairs).
 - b. CM flame rated according to CEC Chapter 8, tested to UL listed as such.
- 5. Electrical performance: Meet or exceed TIA/EIA-568-C.2 for Category 6A, UTP cabling.

2.04 CONDUCTOR CONNECTIONS AND TERMINATIONS

- A. Electrical spring wire connectors:
 - 1. Provide multi-part construction incorporating a non-restricted, zinc coated square cross-section steel spring enclosed in a steel sheet with an outer jacket of plastic and insulating skirt.
 - 2. Self-striping pigtail and tap U-contact connectors shall not be used.
- B. Push-in wire connectors:
 - 1. Multi-port push-in wire connectors for a maximum of 8-wires, as required for specific application. Connectors are manufactured to accommodate a wide range of sizes with either solid or stranded conductors, up to a maximum wire size of #10 AWG. Low insertion force required for ease of installation.
 - 2. Housing shall be 105-degrees C and transparent for visual connection verification.
 - 3. 600 volt maximum rating with copper contacts.
 - 4. UL Listed to 486C and UL 467 Listed for grounding and bonding applications.
- C. Splicing and insulating tape: Provide black, ultraviolet proof, self-extinguishing, 7-mil thick vinyl general purpose electrical tape with a dielectric strength of 10,000 volts suitable for temperatures from minus 18-degrees C to 105-degrees C.
- D. Cable ties: Provide harnessing and point-to-point wire bundling with nylon cable ties. All cable ties shall be installed using tool supplied by Manufacturer of ties.

2.05 HORIZONTAL CABLE TERMINATIONS

- A. Category 6A data system patch panels:
 - 1. Terminations of horizontal distribution cable for data and telephone systems shall be made at Category 6A, 48 port panels.
 - 2. Terminations of horizontal distribution cable for data WAP locations shall be made at Category 6A, 2U, 48 port panels.
- B. Velcro cable ties:
 - 1. Width: 0.75".
 - 2. Color: Velcro cable ties the same color as the cable to which it is applied.

C. Plenum cable ties:

1. Suitable for use in plenums or air handling spaces.
2. Color: Maroon or other distinctive non-white color.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of conductor and cable installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 APPLICATION

- A. All conductor and cable with their respective connectors, fittings and supports shall be UL listed for the installed application and ambient condition.

3.03 INSTALLATION METHODS

- A. Install wires and cables in accordance with manufacturer's written instructions, as indicated on Drawings and as specified herein.
- B. Provide adequate length of conductors within enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal.
- C. Splice conductors only in outlet boxes, junction boxes, pull boxes, manholes or handholes. Group and bundle with tie wrap each neutral with its associated phase conductor where more than one neutral is present in a conduit.
- D. Neatly form, train, and tie the cables in bundles for cabinets, runways, surface raceways, and equipment assemblies.

3.04 CONDUCTOR INSTALLATION

- A. In Raceway:
1. Install wire in raceway in accordance with manufacturer's written instructions, as indicated on the Drawings and as specified herein after interior of building has been physically protected from the weather and all mechanical Work likely to injure conductors has been completed. Pull all conductors into a raceway at the same time. Exercise care in pulling conductors so that insulation is not damaged. Use UL listed, non-petroleum base and insulating type pulling compound as needed.
 2. Completely mandrel all underground or concrete encased conduits prior to installing conductors.
 3. Completely and thoroughly swab raceway system before installing conductors.
 4. Do not use block and tackle, power driven winch or other mechanical means for pulling conductors.
 5. Wire pulling:
 - a. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.

- b. Pull in together multiple conductors or cables in a single conduit.
 - c. Pulling tensions and sidewall pressures shall not exceed 60% of the manufacturer's recommended maximum values. Pulling tension shall be continuously monitored during the pull by a calibrated dynamometer. If pulling tension is exceeded during the pull, immediately notify the engineer to determine if the cables will be considered damaged and require contractor replacement.
- 6. Install and test all cables in accordance with manufacturer's instructions and warranty.
- B. Conductor splices, joints, and terminations:
 - 1. Join and terminate conductors in accordance with UL 486A & C, CEC and manufacturer's instructions.
 - 2. Thoroughly clean wires before installing connectors.
 - 3. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
 - 4. Splices and terminations shall be made mechanically and electrically secure.
 - 5. Where it is determined that unsatisfactory splice or terminations have been installed, remove the devices and install approved devices at no additional cost.
 - 6. Insulate spare conductors with electrical tape and leave sufficient length to terminate anywhere in the enclosure or cabinet.
 - 7. Install cable ties and maintain harnessing.
 - 8. Encapsulate splices in exterior devices, pull boxes and junction boxes using specified insulating resin kits. Make all splices watertight for exterior equipment and equipment in pump rooms.
 - 9. Make up all splices and taps in accessible junction or device boxes with connectors as specified herein. Pigtails and taps shall be the same color as the feed conductor. Form conductor prior to cutting and provide at least 6-inches of tail and neatly packed in box after splice is made up.

3.05 HORIZONTAL CABLE INSTALLATION

- A. Horizontal management panels:
 - 1. Provide the horizontal management panels mounted to racks with one above and one below each patch panel.
 - 2. Provide fasteners and parts required to complete the installation.
- B. Accessories: Provide all accessories as required for a complete installation. Include one bag of rack mounting screws, as come packaged with rack product. Attach the screws directly to the rack, which shall constitute turn-over to the Owner.
- C. Horizontal twisted-pair cabling:
 - 1. Horizontal cable installation and routing:
 - a. Cable runs shall have continuous sheath continuity, homogenous in nature with no splicing.

- b. Cabling shall not exceed a cable length of 295' (90m) from the termination point at the Telecom room to the termination at the workstation outlet, including service slack, when measured using test equipment. The cable length shall be determined by the contractor prior to installing cable with a true tape. Cable lengths exceeding the 295-foot maximum length, shall be brought to the attention of the engineer of record (EOR).
 - c. Place cables within the designated pathways, such as cable tray or basket tray, cable runway, cable hangers, conduit, etc. Do not fasten, support, or attach cables to other building infrastructures (i.e., ducts, pipes, conduits, etc.), other systems (i.e., ceiling support wires, wall studs, etc.), or to the outside of conduits, cable trays and non-approved pathway systems.
 - d. Place and suspend cables during installation and termination in a manner to protect them from physical damage or interference. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
 - e. Route cables at 90-degree angles, allowing for bending radius.
 - f. Do not exceed pulling tension of 25-lbs.
 - g. Do not use cable-pulling compounds.
 - h. Do not exceed a minimum bend radius of 6 times the cable diameter during and after installation.
 - i. Route cables beneath other building infrastructures (i.e. ducts, pipes, conduits, etc.) in above ceiling applications. Do not route cables over building infrastructure/s. The installation shall result in easy accessibility to the cables in the future.
 - j. Place cables 6" minimum away from power sources to reduce interference from EMI.
 - k. Do not set 360-degree service loops in place for slack storage. Instead, set slack as forward-and-back or as figure eights.
 - l. Place a pull string along with cables where run in conduits and spare capacity in conduit remains. Tie off ends of the pull string to prevent the string from falling onto the conduit.
 - m. When exiting the primary pathway, such as cable or basket tray, to the devices, exit via the top of the pathway. Secure the cables to the pathway using an approved Velcro cable tie.
2. Cable routing and dressing within equipment rooms:
- a. Within rooms, only use Velcro type straps on bundles.
 - b. Individual bindles of cable shall not exceed 48 cables to minimize heating of cables that use PoE. Bundles of cables shall be per 48-port patch panel.
 - c. Place cables within the overhead cable support system. When routing vertically on walls, fasten the cables onto vertical supports every 24" on center.

- d. Provide 12" minimum sheath cable slack, length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support system.
 - e. At the rack bay, route, and neatly dress cables from the overhead cable support system into the back of the vertical management sections. Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. Fasten the cables to the cable support bar at the back of the patch panel using approved ties.
3. Termination in the equipment rooms:
- a. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories, and associated management apparatus according to the manufacturer's instructions.
 - b. Properly relieve strain from the cables to and at termination points per manufacturer's instructions. Provide a strain relief bar at the back of the modular patch panels for proper strain relief.
 - c. Modular patch panels and horizontal management panels:
 - 1) Provide quantity of patch panels to support the terminations of cables served from respective equipment room.
 - 2) Install and assemble patch panels and wire management panels according to the manufacturer's instructions.
 - 3) Install the termination hardware and cable management as shown on the Drawings.
 - 4) Terminate cables in sequential order using the link's identifier starting at the top left and completing a block before moving to the next block below.
4. Cable routing and dressing at device connection:
- a. Provide 18" cable slack at each device, length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger or other approved cable support device.
5. Patching and cross connecting: In equipment rooms, provide one modular patch cord for each device connection. Install from the horizontal termination field to the network switches/equipment. Neatly dress patch cords within the horizontal and vertical cable management components. Cords lengths shall be coordinated with the Owners IT representative.
- D. General requirements:
- 1. Labeling, label colors, and identifier assignments shall conform to EIA/EIA-606-C Administration Standards and as approved by the Owner.
 - 2. Provide permanent and machine-generated labels. Handwritten labels will not be accepted.

3.06 IDENTIFICATION

- A. Refer to Section 280553: Electronic Safety & Security Identification for additional requirements.
- B. Conductors:
 - 1. Securely tag all conductors. Mark conductors with specified vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each conductor with the corresponding circuit number.
 - 2. Provide all terminal strips with each individual terminal identified using specified vinyl markers.
- C. Horizontal twisted-pair cables:
 - 1. Labeling shall be per the Owners standards in lieu of the following requirements. Coordinate with the Owners IT representative prior to the labeling phase of the cable installation to determine the Owners labeling requirements.
 - 2. Cables:
 - a. Text color shall be black, #10 font size.
 - b. Label installation:
 - 1) Provide labels on both ends of cable.
 - 2) Install labels such that they are visible by technician from a normal stance.
 - 3) Fully wrap label around the cable jacket (self-lamination).
 - 4) Provide one label within 4" of the termination apparatus.
 - 3. Modular patch panels:
 - a. Text color shall be black, #10 font size.
 - b. Label installation: Provide a Letter designation for each panel (A, B, C etc.). Patch Panel port number will match the cable designation at the station end.

3.07 FIELD QUALITY CONTROL

- A. Refer to Specification Section 280800: Electronic Safety & Security Commissioning.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing required herein. Independent Testing Agency shall meet the requirements as outlined in Section 280010: Basic Electronic Safety & Security Requirements.
- C. Prefunctional testing:
 - 1. Visual and mechanical inspection:
 - a. Compare cable data with Contract Documents.
 - b. Inspect exposed sections of wires and cables for physical damage and proper connections.
 - c. Inspect compression applied connectors for correct cable match and indentation.

- d. Verify visible cable bend meet or exceed ICEA and Manufacturer's minimum allowable bending radius.
- e. Ensure conductor and cable identification has been installed as specified herein.

D. Conductors:

1. Electrical testing:

- a. Contractor shall perform circuit insulation test after installation and prior to connection to utilization devices such as door hardware, cabinets, or appliances. 10% of all circuits shall be tested.
- b. Perform insulation-resistance test using megohm meter with applied potential of 1000 volt DC for a continuous duration of 60-seconds. Test conductors' phase-to-phase and phase-to-ground. Conductors shall test free from short-circuit and ground faults.
- c. Perform continuity test of all circuits to ensure correct connections. Test all neutrals for improper grounds.
- d. Contractor shall furnish instruments, materials, and labor for these tests.

2. Test values: Investigate resistance values less than 50-megohms.

3. Furnish test results in typewritten report form for review and inclusion in the operation and maintenance manuals.

E. Twisted-pair cables:

1. General:

- a. Calibrate test sets and associated equipment per the manufacturer's instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.
- b. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer's discretion, halt testing activity and clean testing equipment, test cords and related apparatus.
- c. Permanently record test results electronically within test equipment at the time of testing.

2. Twisted-pair testing:

- a. Test for UTP cabling as follows:

TESTS FOR CATEGORY 6 CABLING TABLE				
Subsystem	Type	Test	Configuration	Notes
Horizontal		Category 6A	Permanent Link	Per TIA/EIA-568-C.2

- b. Precautions:

- 1) Adhere to the equipment manufacturer's instructions during all testing.

- 2) Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature, approximately 70-degrees F.
 - 3) Fully charge power sources before each day's testing activity.
- c. Horizontal twisted pair testing:
- 1) Test equipment set-up:
 - a) Set-up the tester to perform a full Category 6A test, as a Permanent Link configuration.
 - b) If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6A cable.
 - c) Set the tester to save the full test results (all test points, graphs, etc.).
 - d) Save the test results with associated cable link identifier.
 - e) Calibrate the test set per the manufacturer's instructions.
 - 2) Acceptable test results measurements:
 - a) Overall test results:
 - (1) Links which report a Fail, Fail or Pass for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
 - (2) Any reconfiguration of link components required because of a test Fail, must be re-tested for conformance.
 - (3) Remove and replace any cabling links failing to meet the criteria described in this Specification, at no cost to the Owner, with cables that prove to meet the minimum requirements.
 - b) Wire map: Provide continuous pairs and terminate all the cabling links correctly at both ends, no exceptions taken.
 - c) Length: One hundred meters (328 feet) is the maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration, including test cords.
 - d) Insertion loss: The acceptable insertion loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
 - e) Worst pair-to-pair near end crosstalk (NEXT) loss: The acceptable worst pair-to-pair NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - f) Power sum NEXT loss: The acceptable power sum PS-NEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - g) Worst pair-to-pair ELFEXT and FEXT loss: The acceptable worst pair-to-pair ELFEXT and FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.

- h) Power sum ELFEXT and FEXT loss: The acceptable PS-ELFEXT and PS-FEXT loss for any horizontal cable is that which is no greater than that listed in TIA/EIA-568-C.2.
 - i) Return loss: The acceptable return loss measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
 - j) Propagation delay and delay skew: The acceptable propagation delay and delay skew measurements for any horizontal cabling link is that which is no greater than that listed in TIA/EIA-568-C.2.
3. Record documents:
- a. Permanently record all test results.
 - b. Export test results' numerical values to a single Microsoft Excel spreadsheet.
 - c. Submit test results in a format acceptable to the Owner, Owner's Representative, and the Engineer before system acceptance.
 - d. Cable and pair identifiers of the test reports shall match the identifiers as labeled in the field, i.e. use the same ID on the cable/termination label as what appears on the test report.
 - e. Measurements shall carry a precision through one significant decimal place, minimum.
 - f. Use feet for the units for measurements shown on the print of the test measurements.
 - g. Print report such that fiber strands of a given cabling link have matching axis scales. The "X" and the "Y" axis shall be the same from report-to-report.
 - h. The trace of the printed test report shall show the launch cord.
 - i. For each cabling link, include either a schematic graphic or a brief narrative accurately describing the test set-up. The description shall include test/launch cord (with length), expected events (connectors, slices, etc.) with expected distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.
 - j. For each twisted pair horizontal cable test, report shall contain the following information:
 - 1) Project name and address.
 - 2) Test company's and Operator's name.
 - 3) Date measurements were taken.
 - 4) Test equipment type to include model and serial numbers.
 - 5) Cable identification number and pair number.
 - 6) Measurement results.

3.08 INSPECTION AND ADJUSTMENTS

- A. Contractor shall inspect all installed Work in conjunction with the General Contractor and develop a "punchlist" for all items needing correction. Provide punchlist to the Engineer prior to their final walk of Project.
- B. Punchlist work and the required remediation shall be performed prior to system final acceptance.
- C. Replace or repair work completed by others that was defaced or destroyed during the installation of the electronic safety and security conductor and cable system by this contractor.
- D. Make changes to adjust the system to optimum operation for final use. Contractor is responsible for making changes to the system such that any defects in workmanship are correct and all cables and the associated termination hardware passes the minimum test requirements.

3.09 CLEANING

- A. Remove all unused, excess, and left-over products, to include debris, spills, and installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean conditions with no evidence of damage.
- C. Legally dispose of debris.
- D. Clean installed products in accordance with manufacturer's instructions prior to final punch list.

END OF SECTION 280513

SECTION 280528

ELECTRONIC SAFETY& SECURITY PATHWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit and fittings.
 - 2. Fire-rated wall and floor through-penetration.
 - 3. Boxes
 - 4. Vaults
 - 5. J-Hooks.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01: Cutting and patching.
 - 2. Division 31: Earthwork. Excavation and backfill for conduit and utilities on Project site.
 - 3. Division 03: Cast-in-place concrete. Protective envelope for underground conduit installations.
 - 4. Division 07: Sheet metal flashing and trim.
 - 5. Division 09: Painting. Exposed conduit and other devices.
 - 6. Division 08: Access doors. Wall and ceiling access doors.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI)/National Electrical Manufacturer Association (NEMA):

ANSI C80.3;	Electrical Metallic Tubing, Zinc Coated.
ANSI/NEMA OS-1; Supports.	Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box
NEMA 250;	Enclosures for Electrical Equipment (1000 volts maximum).
2. American Society for Testing and Materials (ASTM):	
ASTM E84;	Surface Burning Characteristics of Building Materials
ASTM E119;	Fire Tests of Building Construction and Materials
ASTM E814;	Fire Tests of Penetration Fire Stops

ASTM E1725; Standard Test Methods for Fire Tests of Fire Resistive Barrier Systems for Electrical System Components

3. Underwriters Laboratories, Inc. (UL):

UL 50; Enclosures for Electrical Equipment, Non-Environmental Considerations.

UL 263; Fire Tests of Building Construction and Materials

UL 514A; Metallic Outlet Boxes.

UL 514B; Conduit, Tubing and Cable Fittings.

UL 635; Insulating Bushings.

UL 651; Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

UL 651A; Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.

UL 723; Surface Burning Characteristics of Building Materials

UL 797; Electrical Metallic Tubing - Steel.

UL 1479; Fire Tests of Through Penetration Firestops

UL 1773; Termination Boxes.

UL 2239; Hardware for the Support of Conduit, Tubing, and Cable

4. National Electrical Manufacturer Association (NEMA):

NEMA TC 2; Electrical Plastic Tubing and Conduit.

NEMA TC 3; PVC Fittings for use with Rigid PVC Conduit.

NEMA TC 6; PVC Plastic Utilities Duct (EB and DB Type)

NEMA TC 9; Fittings for PVC Plastic Utilities Duct (EB and DB Type)

1.03 SYSTEM DESCRIPTION

- A. Conduits supported from structure and within stud walls for the continuous routing of electronic safety and security conductors and cables, where non-accessible concealed Work is indicated and where required by Code and/or shown on the Drawings. Conduits shall be sized for a 40-percent maximum cable fill ratio.
- B. Assemblies supported from structure for the continuous routing of electronic safety and security conductors and cables, where exposed Work is indicated on the Drawings.
- C. J-Hooks supported from structure, above suspended ceiling, for the routing of electronic safety and security conductors and cables, where accessible through ceiling and where shown on the Drawings. J-hooks shall be sized for a 40-percent maximum cable fill ratio.
- D. Where exposed cable routing is indicated, provide conduit sleeves through walls, above suspended ceilings or at cable routing elevation, with insulated bushings on both ends, for access into enclosed spaces, i.e., offices, workrooms, conference

rooms, etc. Sleeves shall be 2" minimum and 4" maximum conduits and shall be sized for a 40-percent maximum cable fill ratio.

- E. Provide UL listed fire-rated sleeves for passing through 1 and 2-hour rated walls and/or floors assemblies.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 - 4. Submit Manufacturer's installation instructions.
 - 5. Complete Bill of Material listing all components.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
 - 1. Conduit:
 - a. Metal conduit:
 - 1) Allied Tube and Conduit Co.
 - 2) Triangle PWC, Inc.
 - 3) Western Tube and Conduit Corp.
 - b. Nonmetallic conduit:
 - 1) Prime Conduit.
 - 2) JM Eagle.
 - 3) Cantex.
 - c. Fittings:
 - 1) Appleton Electric Co.
 - 2) OZ/Gedney.

- 3) Thomas & Betts Corp.
- 4) Carlon.
2. Fire-rated penetration assemblies:
 - a. EZ-Path, STI Firestop.
 - b. Hilti
 - c. 3M
 - d. Lowry's, Inc.
3. Boxes:
 - a. Outlet and junction boxes:
 - 1) Spring City Electrical Manufacturing Co.
 - 2) Thomas & Betts Corp.
 - 3) Racor, Inc.
 - b. Cast boxes:
 - 1) Appleton Electric Co.
 - 2) Crouse-Hinds.
 - c. Floor boxes:
 - 1) Hubbell Inc.
 - 2) Walker.
 - 3) Wiremold/Legrand.
 - d. Pullboxes:
 - 1) Circle AW Products.
 - 2) Hoffman Engineering Co.
4. Precast concrete vaults:
 - a. Oldcastle Enclosure Solutions.
 - b. Jensen Precast.
5. J-Hooks Systems:
 - a. Erico nVent Caddy HP.
 - b. B-Line.
 - c. Panduit.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 CONDUIT

- A. Electrical metallic tubing (EMT):
 1. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication.

Conduit shall conform to ANSI C80.3 Specifications and shall meet UL requirements.

2. Set screw type couplings: Hot dip galvanized, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2-inches. Setscrews shall be of case-hardened steel with hex-head and cup point to firmly seat in wall of conduit for positive grounding.
3. Set screw type connectors: Hot dip galvanized, steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150-degree C temperature rated. Setscrew shall be same as for couplings.
4. Raintight couplings: Hot dip galvanized, steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
5. Raintight connectors: Hot dip galvanized, steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.

B. Rigid non-metallic conduit (PVC)

1. Conduit:
 - a. Rigid polyvinyl chloride, Schedule 40 or 80 conforming to NEMA TC1 and UL 651, latest edition. UL listed for exposed and direct-burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
 - b. Rigid polyvinyl chloride, Type EB or DB conforming to NEMA TC 6 and UL 651, latest edition. UL listed for concrete encased burial and direct burial applications and for 90 degrees C conductor insulation. Conduit shall include an integral bell fitting at one end.
2. Fittings: Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.

C. Miscellaneous conduit fittings and products:

1. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.
2. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
3. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
4. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate 0.75-inch deflection, expansion or contraction in any direction and allow 30-degree angular

deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless-steel jacket clamps. Unit shall comply with UL467 and UL514. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.

5. Standard products not herein specified:
 - a. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
 - b. Listing shall include Manufacturers name, part numbers and a written description of the item indicating type of material and construction.
 - c. Miscellaneous components shall be equal in quality, material and construction to similar items herein specified.

2.03 FIRE-RATED WALL AND FLOOR THROUGH-PENETRATION

A. General:

1. Through-penetration firestop system shall have been tested for specific fire resistance rated construction conditions or acoustical and smoke related requirements conforming to construction assembly type, penetrating item type, annular space requirements, and rating involved for each separate instance.
2. Firestop rating shall match that of the wall or floor construction being penetrated.
3. Firestop systems shall be as outlined below:
 - a. Firestop putty.
 - b. Firestop putty pads.
 - c. Fire-rated cable pathways.

B. Firestop putty:

1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers, or silicone compounds.
2. Putty shall be used to seal openings around conduit penetrations through rated walls or floors, to maintain the construction rating.

C. Firestop putty pads:

1. Intumescent, non-hardening, pliable putty pads designed to seal both through and membrane penetrations against the spread of fire and smoke around outlet boxes in rated construction.
2. The pads are 6" x 8" x 0.125" thick.
3. Pads are rated for up to 4-hour rated wall assemblies.

D. Fire-rated pathway penetrations:

1. Pathway penetrations shall be used in fire-rated construction for low-voltage conductors and cabling, where they pass through fire-rated wall or floor construction.
2. Pathways shall consist of an enclosed heavy-gauge galvanized steel housing lined with intumescent material engineered for rapid expansion when exposed to

fire or high temperatures, quickly sealing the pathway, and preventing the passage of flames and smoke. The pathway shall be approximately 4" square x 14" long.

3. Pathways shall meet the hourly fire-rating of fire rated wall and/or floor penetrated.
4. Pathways shall be tested for the surrounding construction and cable types involved.
5. Pathways shall be UL Systems permitting cable loads from 0 to 100-percent fill. This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
6. Pathway shall be maintenance-free, having a corresponding Evaluation Services Report from a Nationally Recognized Third-Party Laboratory. Maintenance-free is defined as no action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
 - a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.
 - c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of "Maintenance-Free" and all relevant codes and standards.
7. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
8. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

2.04 OUTLET BOXES

A. Standard outlet box:

1. Provide galvanized, one-piece die formed or drawn steel or welded, knockout type box of size and configuration best suited to the application indicated on the Drawings.
2. 4.687-inch square by 2.125-inch deep shall be minimum box size.
3. ANSI/NEMA OS 1.

B. Concrete box:

1. Provide galvanized steel, 4-inch octagon rings with mounting lugs, backplate and adapter ring as required.
2. Select height as necessary to position knockouts above concrete reinforcing steel.

3. ANSI/NEMA OS 1.
- C. Pull and junction boxes:
 1. Sheet metal pull and junction box:
 - a. Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
 - b. ANSI/NEMA OS 1.
 2. Cast metal pull and junction box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
 3. Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.

2.05 VAULTS

- A. Precast concrete: Concrete mix and reinforcing placement shall be in accordance with ACI 318. Design tops and wall structures for AASHTO H20 highway loading, with 30 percent loading added for impact. Walls shall withstand all soil pressures, taking into consideration the soil encountered and ground water level present at the Project site. Assume ground water level three feet below ground surface unless a higher water table is indicated in soils report.
- B. Construction:
 1. Monolithic or modular assembled sections.
 2. Assembled sections shall have mating edges with tongue and groove joints. Joints shall firmly interlock adjoining components and provide waterproof junctions. Seal joints watertight using preformed plastic strip.
 3. Provide lifting devices cast into units for proper handling of units.
 4. Identify all structures with Manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
 5. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- C. Size and dimensions: As indicated on Drawings.
- D. Accessories:
 1. Frames and covers: Cast iron with cast-in legend "SECURITY" or "LOW-VOLTAGE" as appropriate. Machine cover-to-frame bearing surfaces.
 2. Pulling eyes in walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load embedded in 6-inch, 4000-PSI concrete: 13,000 pounds minimum tension.
 3. Pulling and lifting irons in floor: 7/8-inch diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.

4. Bolting inserts for cable stanchions: Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive thermoplastic material; 1/2-inch internal diameter by 2.75-inch deep, flared to 1.24-inch minimum at base. Tested ultimate pull-out strength at 12,000pounds minimum.
5. Expansion anchors for installation after concrete is cast: Zinc-plated carbon steel wedge type with stainless-steel expander cup 1/2-inch bolt size, 5,300 pound rated pull-out strength and 6800pound rated shear strength minimum.
6. Cable stanchions: Hot-rolled, hot-dipped, galvanized "T" section steel, two 1/4-inches size, punched with 14-holes on 1.5-inch centers for cable arm attachment.
7. Cable arms: 3/16-inch thick hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12-inches wide by 14-inches long and arranged for secure mounting in horizontal position at any position on cable stanchions.
8. Cable support insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.
9. Ground rods: Solid copper, 3/4-inch diameter by 10-feet length (minimum).
10. Ground wire: Stranded bare copper conductor, #6 AWG (minimum). Size in accordance with CEC Article 250.
11. Steps: Cast iron, suitable for shape and construction.

2.06 J-HOOK "NON-CONTINUOUS" CABLE SUPPORT SYSTEM

A. General:

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables per ANSI/TIA 568.0-D.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hook shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
4. J-hook shall have a hot-dipped galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. J-hook shall be made using a metal thickness of 0.052" and in a finish and hardness.
6. Attaching J-hooks and assemblies to ceiling support wires is not allowed per the CEC.

B. Multi-tiered field assemblies:

1. Multi-tiered J-hook assemblies shall be used where separate cabling compartments are required. Assemblies may be created by joining the J-hook with snap-on tree-mounting brackets. Assemblies can be made single-sided for wall-mount applications or single/double sided for ceiling/beam/threaded rod suspended applications. The assembly is rated for indoor use in non-corrosive environments.
2. For installation on threaded rod, a snap-on angle bracket must be added on top of the assembly.

3. If required, the multi-tier J-hook assembly can be attached to snap-on angle or straight brackets riveted to beam clamps, flange clips, angle brackets, etc.
- C. Factory assembled multi-tier J-hook assemblies: The assemblies shall be used where separate cabling compartments are required. These assemblies are assembled by the factory. Multi-tier assemblies are available for specific applications including wall mount, ceiling mount, threaded rod mount, and beam/flange mount. The beam/flange mount assembly shall include a beam clamp rated to hold the weight of any of the multi-tier configurations. Assemblies shall be available in 1, 2, 3, & 4 tier double-sided and 2, 3, & 4 tier in single-sided configurations. The assembly shall be rated for indoor use in non-corrosive environments.
- D. J-hook assemblies shall be furnished with appropriate fittings and add-on devices to allow for supports in multiple applications. Support fittings and add-on devices include beam or flange fasteners, threaded rod fasteners, support wire fasteners, construction channel support fasteners, wall or concrete or joist fasteners, raised access floor pedestal supports, etc.
- E. J-hook assemblies from acoustic tee bar: Acoustical tee bar bracket riveted to one 1" J-hook, factory assembled; rated for in-door use in non-corrosive environments. Request permission from local AHJ before using.
- F. Finishes: ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel, or ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic Coated by the Hot Dip Process
- G. Material: Base material of the J-hooks shall be metal (at least a 0.052" thickness). Any fasteners used to affix the J-hooks shall also be metal and shall be fastened to the metal of the J-hook support.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of pathway installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 CONDUIT APPLICATION

- A. Electrical metallic tubing (EMT): Shall be used exposed or concealed for interior electronic safety and security conduits 4" and smaller, where run above suspended ceilings, in concrete slabs and walls not in contact with earth; in stud walls, furred spaces and crawl spaces. EMT shall not be installed exposed below 6 feet above the finish floor except within equipment rooms or closets.
- B. Rigid non-metallic conduit (PVC): Shall be used in the following applications:
 1. Direct burial ducts: Schedule 80, minimum 24-inches below finished grade.
 2. Concrete encased ducts: Type DB, minimum 30 inches below finished grade.
 3. Below building slab-on-grade: Schedule 80, minimum 4-inches below bottom of slab except that bends and penetrates through floor slab shall be insulated galvanized rigid steel conduit.
 4. Below roads and paved surfaces:

- a. Schedule 80, minimum 36-inches below finished grade.
- b. Concrete encased type DB, minimum 30 inches below finished grade.
5. Penetrations of building and equipment slabs: Schedule 80 conduit.
6. Slope duct to drain towards vaults and away from building and equipment entrances. Pitch not less than 4-inches per 100-feet.
7. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 25-feet in the horizontal and vertical directions. The use of manufactured bends is limited to building entrances and equipment stub-ups.
8. For electronic safety and security conduits, do not exceed a combined bend radius of greater than 270 degrees between pull points.
9. Underground conduit stub-ups to inside of building and exterior equipment shall be Schedule 80 conduit.
10. Make joints in ducts and fittings watertight according to Manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
11. Terminate duct lines at vaults with end bells spaced 10-inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing duct line slope and without forming trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrance.
12. Separation between direct buried duct lines shall be 3-inches minimum for like systems and 12-inches minimum between power and communication ducts.
13. Concrete encased ducts:
 - a. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts material throughout the installation.
 - b. Rigid PVC spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3-inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed 5-feet.
 - c. Provide non-ferrous tie wires to prevent displacement of the ducts during pouring of concrete.
 - d. Separate ducts 3-inches for like systems and 6-inches between power and signal ducts.
14. For direct burial installations install continuous warning strip of heavy gage plastic imprinted "low-voltage ducts below", approximately 12-inch wide at 12-inches above ducts.
15. Mandrel all ducts upon completion of installation and prior to pulling cables.

3.03 PREPARATION

A. Conduit:

1. Locations of conduit runs shall be planned in advance of the installation and

2. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
 3. All conduits shall be run parallel or at right angles to the centerlines of columns and beams, whether routed exposed, concealed above suspended ceiling or in concrete slabs.
 4. Electronic safety and security conduits shall not be placed closer than 12-inches to power, a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
 5. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
 6. The largest trade size conduits in concrete floor and wall slabs shall not exceed 1/3 the floor or wall thickness and conduits shall be spaced a minimum of three conduit diameters apart unless otherwise noted on the Drawings. All conduits shall be installed in the center of concrete slabs or wall and shall not be placed between reinforcing steel and the bottom of floor slabs.
 7. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150-feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.
 8. Electronic safety and security conduit bends shall not exceed 270-degrees within any single run of conduit.
 9. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated, or specified in the Contract Documents or not.
- B. Boxes:
1. Install all outlet boxes flush with building walls, ceilings, and floors.
 2. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
 3. Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Adjust locations as required by structural conditions and to suit coordination requirements of other trades.
 4. Do not install outlet boxes back-to-back, separate boxes by at least 6". In fire-rated walls separate boxes by at least 24" and wall stud.
 5. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for boxes.
- C. J-hooks:
1. Location of J-hooks shall be planned in advance of the installation and

2. J-hooks shall not be placed closer than 12-inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.
3. J-hooks shall not be placed closer than 3-inches to any branch circuit power raceway.

3.04 INSTALLATION

A. Conduit:

1. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Minimum electronic safety and security conduit size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1" for interior applications and 2" for exterior and underground applications.
3. All electronic safety and security conduit sizes indicated on the Drawings are sized for 40-percent fill or less. If cable type or size is changed the Contractor shall be responsible for resizing conduits upward to meet a maximum 40-percent fill.
4. In general, all conduit work shall be concealed where possible. Exceptions shall be equipment rooms, exposed ceiling areas, and parking garages.
5. Install conduits in complete runs before pulling in cables or wires.
6. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
7. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
8. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
9. In all empty conduits or ducts, install a "True Tape" conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
10. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
11. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
12. A run of electronic safety and security conduit between terminations at wire pulling points shall not contain more than the equivalent of three-quarter bends (270-degrees, total).

B. Fire-rated cable pathways:

1. Install cable pathways in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.

2. Install pathways using mounting plates and gasketing that comes with equipment for the application of each installation.
3. Where multi-gang pathway penetrations occur, use framing hardware brackets recommended by manufacturer for specific applications. Pathways shall be furnished with insert hooks and eye windows to connect units together and align them for multi-gang installations.

C. Boxes:

1. Install boxes in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Locate electrical boxes as indicated on Drawings.
3. Install junction or pullboxes where required to limit bends in conduit runs to not more than 270-degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.
4. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
5. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
6. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
7. Welded outlet boxes shall only be used in concealed interior installations.
8. Provide an access panel in permanent ceiling or wall where boxes are installed and will be inaccessible.
9. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
10. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

D. Vaults:

1. Install precast assembly in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Install cast iron frame and cover. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1-inch above finished grade.
3. Units shall be installed on a level 12-inch bed of well-tamped gravel or crushed stone.
4. Install drains in bottom of units where indicated.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms and insulators, as required for installation and support of cable and conductors and as indicated.

6. Do not drill deeper than 3-7/8" for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.

E. J-hooks:

1. Install J-hooks in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.
2. Support J-hooks every 48-inches or less throughout the cable pathway.
3. J-hook support shall consist of 1/4" to 3/8" threaded rods supported from structure above, to structural wall studs with #10 wood or Tek screws or to #12 ceiling wire (independent of ceiling support) to structure.

3.05 PENETRATIONS

A. Conduit:

1. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, wall, etc. Penetrations are acceptable only when the following occurs:
 - a. Where indicated on the Structural Drawings.
 - b. As approved by the Structural Engineer prior to construction and after submittal of Drawing showing location, size, and position of each penetration.
2. Cutting or holes:
 - a. Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - b. Provide sleeves or "can outs" for cast-in-place concrete floors and walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack grouting compounds; or fire rated penetration-sealing materials.
 - c. Cut holes for conduit penetrations through non-concrete and non-masonry walls, partitions, or floors with a hole saw. The hole shall be only as large as required to accommodate the size of the conduit.
 - d. Provide single piece escutcheon plates around all exposed conduit penetrations in public places.
3. Sealing:
 - a. Non-rated penetrations: Pack opening around conduits with non-flammable insulating material and seal with gypsum wallboard taping compound.
 - b. Firestop: Where conduits and other electronic safety and security raceways pass through fire-rated partitions, walls, smoke partitions or floor; install a UL classified fire-stop material to provide an effective barrier against the spread of fire, smoke, and gases. Completely fill and seal clearances between raceways and openings with the fire-stop material.

4. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07: Sealants and Caulking.
 - a. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be Schedule 80 PVC conduit.
 - b. For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets as specified under Roofing and Sheet Metal Sections of the Specifications.
 - c. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
 - d. Conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.06 CONDUIT CONCEALED IN CONCRETE

- A. Install conduits approximately in the center of the slab so that there will be a minimum of 1-inch of concrete around the conduits.
- B. Installation of conduit in structural concrete that is less than three inches thick is prohibited. Topping slabs, maintenance pads and curbs are exempted.
- C. Tie conduits to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- D. Where nonmetallic conduit or tubing is used, raceways must be converted to EMT conduit before rising above floor.
- E. Make couplings and connections watertight.
- F. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3.07 UNDERGROUND CONDUIT INSTALLATION

- A. Perform trenching, backfilling and compaction operations as specified in Division 31: Trenching.
- B. Tops of conduits shall be as follows unless otherwise noted:
- C. Not less than 18-inches below finished grade.
- D. Not less than 30-inches below roadways, paved parking lots, driveways or any surface subject to vehicular traffic.
- E. Not less than 4-inches below building floor slab for branch circuits. Major feeders and large signal conduits (2" and greater) at not less than 18-inches.
- F. Furnish and install specified underground conduit marker 12" above conduits in trenches with all buried conduits.

3.08 CONDUIT TERMINATIONS AND JOINTS

- A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
- C. Stub-up connections: Extend conduits through concrete minimum of 3" and terminate with insulated bushing.
- D. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating inside the building. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction, or outlet boxes.
- E. Install expansion couplings where any conduit crosses a building separation or expansion joint as follows:
 - 1. Conduits three inches and larger, shall be rigidly secured to the building structure on opposite sides of a building expansion joint and provided with expansion or deflection couplings. Install the couplings in accordance with the Manufacturer's recommendations.
 - 2. Conduits smaller than three inches shall be rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15-inches of slack flexible conduit. Flexible conduit shall have a green copper ground-bonding jumper installed. For concrete embedded conduit, use expansion and deflection couplings as specified above for three inches and larger conduits.

3.09 SUPPORTS

- A. Conduit:
 - 1. Provide supports for raceways as specified in Section 280529: Electronic Safety & Security Hangers and Supports.
 - 2. All raceways systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.
 - 3. Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp backs" to space conduit off the surface.
 - 4. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from specified construction channel, mounted to 3/8-inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.
 - 5. Fasteners and supports in solid masonry and concrete:
 - a. Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - b. After concrete installation:
 - 1) Steel expansion anchors not less than ¼ inch bolt size and not less than 1-1/8" embedment.

- 2) Power set fasteners not less than ¼-inch diameter with depth of penetration not less than 3-inches.
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
 6. Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.
 7. Metal structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- B. Boxes:
1. Provide boxes installed in metal stud walls with brackets designed for attaching directly to the studs or mount boxes on specified box supports.
 2. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.
 3. Support boxes independently of conduit system.
 4. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted luminaires are to be installed from the box.
 5. Support boxes mounted above suspended acoustical tile ceilings, directly from the structure above.

3.10 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint any marks, blemishes or other finish damage suffered during installation.

END OF SECTION 280528

SECTION 280529**ELECTRONIC SAFETY & SECURITY HANGERS & SUPPORTS PART 1 -****GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit supports.
 - 2. Equipment supports.
 - 3. Fastening hardware.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 05: Miscellaneous metals. Hangers for electronic safety and security equipment.
 - 2. Division 09: Ceiling suspension systems. Slack support wires.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Underwriters Laboratories, Inc. (UL):

UL 2239; Hardware for the Supports of Conduit, Tubing and Cable.

1.03 SYSTEM DESCRIPTION

- A. Provide devices specified in this Section and related Sections for support of electronic safety and security equipment furnished and installed under Division 28.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit Manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.

- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Concrete fasteners:
 - a. Phillips "Red-Head".
 - b. Remington.
 - c. Ramset.
 2. Concrete inserts and construction channel:
 - a. Unistrut Corp.
 - b. GS Metals "Globe Strut."
 3. Conduit straps:
 - a. O-Z/Gedney.
 - b. Erico "Caddy" Fastening Products.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 CONCRETE FASTENERS

- A. Provide expansion-shield type concrete anchors.
- B. Provide powder driven concrete fasteners with washers. Obtain approval by Architect and Structural Engineer prior to use.

2.03 CONCRETE INSERTS

- A. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

2.04 THREADED ROD

- A. Provide steel threaded rod, sized for the load unless otherwise noted on the Drawings or in the Specifications.

2.05 CONSTRUCTION CHANNEL

- A. Provide 1.5-inch by 1.5-inch (nominal), 12-gauge galvanized steel channel with 17/32-inch diameter bolt holes and 1.5-inch on center in the base of the channel.

2.06 CONDUIT STRAPS

- A. One-hole strap, steel, or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
1. Use malleable strap with spacers for exterior and wet locations.

- 2. Use steel strap without spacers for interior locations.
- B. Steel channel conduit strap for support from construction channel.
- C. Steel conduit hanger for pendant support with threaded rod
- D. Steel wire conduit support strap for support from independent #12-gauge hanger wires.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of supporting device installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 PREPARATION

- A. Coordinate size, shape, and location of concrete pads with Division 03, Cast-in-place concrete.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.

3.03 INSTALLATION

- A. Furnish and install supporting devices as noted throughout Division 28.
- B. Electronic safety and security devices and conduit support shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlets, and junction boxes to building structure using precast inserts, expansion anchors, preset inserts, or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsumboard partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the Architect or Structural Engineer.
- J. Fabricate supports from 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.
- K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.

- L. Bridge studs top and bottom with channels to support flush mounted cabinets in stud walls.

3.04 ERECTION OF METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.05 WOOD SUPPORTS

- A. Cut, fit, and place wood nailers, blocking and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.06 ANCHORAGE

- A. All floor mounted, free standing electronic safety and security equipment such as racks and cabinets etc., shall be securely fastened to the floor structure.
- B. Anchorage of electronic safety and security equipment shall comply with the seismic requirements as outlined in Section 280010: Basic Electronic Safety & Security Requirements.

END OF SECTION 280529

SECTION 280553**ELECTRONIC SAFETY & SECURITY IDENTIFICATION PART 1 - GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Electronic safety and security equipment rack and cabinet nameplates.
 - 2. Wire and cable identification.
 - 3. Junction box identification.
 - 4. Field device identification.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:
 - 1. Electronics Industries Alliance (EIA):
EIA 230; Color Marking of Thermoplastic Wire.
 - 2. Telecommunications Industry Association (TIA) / Electronics Industries Alliance (EIA):
TIA/EIA-606-A; Administration Standard for Commercial Telecommunications Infrastructure

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Schedules for nameplates to be furnished.

1.04 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Equipment rack and cabinet nameplates:
 - a. Chatsworth Product Inc. (CPI).
 - b. Cooper/B-Line Systems, Inc.
 - c. Great Lakes.
 - d. Panduit.
 - e. Ortronics.
 2. Conduit and wire markers:
 - a. Thomas & Betts Corp.
 - b. Brady.
 - c. Griffolyn.
 3. Inscription Tape:
 - a. Kroy.
 - b. Merlin.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 NAMEPLATES FOR EQUIPMENT AND RACKS

- A. Engraved, plastic laminated labels, signs, and instruction plates. Engrave stock melamine plastic laminate 1/16-inch minimum thickness for signs up to 20 square inches or 6-inches in length and 1/8-inch thick for larger sizes. Engraved nameplates shall have white letters and be punched for mechanical fasteners.
- B. Color and letter height as specified in Part 3: Execution.

2.03 HORIZONTAL CABLE LABELS

- A. Twisted pair cables.
- B. Self-laminating adhesive laser labels.
- C. Machine printable with laser printer.
- D. Color: White with black lettering

2.04 FIELD DEVICE LABELS

- A. Self-laminating, type-on-tape, adhesive labels.
- B. Imprinted or thermal transfer characters onto tape lettering system.
- C. Tape trimmer.
- D. Matte finish spray-on clear coating.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of identification device installation to verify conformance with Manufacturer and

Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 NAMEPLATES

A. Installation:

1. Degrease and clean surfaces to receive nameplates.
 2. Install nameplates parallel to equipment lines.
 3. Secure nameplates to equipment fronts using machine screws.
- B. Provide type 'NP' color coded nameplates that present, as applicable, the system and equipment designations.
- C. Nameplates for electronic safety and security systems equipment and devices are to be black. Nameplates for fire alarm system equipment shall be red.
- D. Minimum letter height for equipment cabinets, terminal cabinets, control panels and other cabinet enclosures shall use 3/8" high letters to identify equipment designation.

3.03 EQUIPMENT RACKS AND CABINETS

- A. Labeling and identifier assignments shall conform to the TIA-606 Standard and as approved by the Owner before installation.
- B. Provide two label nameplates per rack. Permanently affix label nameplates centered on the rack's front top angle and back top angle.
- C. Provide two label nameplates per cabinet. Permanently affix label nameplates centered at the top of cabinet's front door and back door.

3.04 CABLING AND INSCRIBED DEVICE COVERPLATE

A. General:

1. Lettering type: Helvetica, 12-point or 1/8" high.
2. Color of characters shall be black.
3. Locate the top of the inscription 1/2" below the top edge of the coverplate.
4. Inscription shall be centered and square with coverplate.

B. Application:

1. Provide inscribed coverplates for devices as outlined below:
 - a. Telecommunication outlets.
2. Type-on-tape inscriptions shall be provided for the following devices:
 - a. Telecommunication outlets.
3. Type-on-tape installation:
 - a. Tape shall be trimmed to the height of the letters.
 - b. Trim tape length to 1/4 inch back from each edge of coverplate.
 - c. Contractor hands shall be clean or covered with surgical type glove prior to application of tape. Tape installations with visible fingerprints or smudges will not be acceptable.

3.05 CLEANING

- A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean all equipment per Manufacturers approved methods and materials. Remove paint splatters and other spots, dirt, and debris.
- B. Touch-up paint for any marks, blemishes or other finish damage suffered during installation.

END OF SECTION 280553

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(Not for Bidding)

SECTION 281300**SECURITY ACCESS CONTROL SYSTEM****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
1. Access control system server hardware
 2. Access control system server software.
 3. Intelligent controller.
 4. Two door controller modules.
 5. In/out modules.
 6. Proximity card readers.
 7. Door monitoring switches.
 8. Access control cards.
 9. Request to exit modules.
 10. Power supplies and accessories.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
1. Division 08: Door Hardware
 2. Division 26: Electrical

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

1. Underwriters Laboratories, Inc. (UL):

UL 13;	Power-Limited Circuit Cables.
UL 294;	Access Control System Units.
UL 603;	Power Supplies for Use with Burglar-Alarm Systems.
UL 639;	Intrusion-Detection Units.
UL 1076:	Proprietary Burglar Alarm Units and Systems.

2. Electronics Industries Alliance (EIA):
EIA: Testing standards.

1.03 SYSTEM DESCRIPTION

- A. General requirements:

1. Provide a complete access control system
2. The system shall be comprised of all necessary supervision, processing, display, and printout circuitry and/or devices. It shall also have redundant circuitry to ensure that no single independent failure of any component or component group shall cause consequential failure of the system.
3. The system shall include door readers, door monitoring contacts, input/output modules, ethernet interface modules, door controller modules, system software, power supplies, batteries, proximity cards, ID Card encoder software and printer, and other any other devices required for a fully operational system.

B. Overview:

1. A centralized computer shall monitor door readers, door monitoring contacts, and other security devices located as shown on the Drawings. The system shall be expandable and have a minimum capacity of 3,500 active cards.
2. Contractor shall program the system to permit card holders access to entry doors as authorized by location, time zone, and other parameters as determined by Owner.
3. The access control system shall control electric door locks, strikes, and other devices as shown on the Drawings.
4. All system activity shall be displayed on a video control terminal located as determined by the Owner, as well as logged on the computer hard-disk drive. Specific events shall also be recorded on the system printer, if determined by the Owner.
5. The video terminal shall display a custom English-Language description of the location and type of device reporting activity, as well as the date and time. Routine (authorized) access entries shall be logged on the disk-drive, but not displayed on the terminal.
6. It shall be possible to manually lock or unlock any door electric locking devices connected to the access control system by means of keyboard commands.
7. Display alarm signals and provide control interface to custom monitoring stations, as specified and shown on the Drawings. Provide inputs and outputs to the control panel and to field devices.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment and dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.

- a. Plot plans and building floor plans, showing location of and conduit routing to all devices.
 - b. Point-to-point wiring diagram in block or riser formats showing all components, conduit and wire types and sizes with cable legend.
 - c. Include elevations of control panel and remote terminal cabinet(s).
4. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 5. Submit Manufacturer's installation instructions.
 6. Complete bill of materials listing all components.
 7. Warranty.

1.05 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, to include the following:
 1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic Drawings of wiring system, including all devices, control panel, terminal cabinets, etc.
 5. Telephone numbers for the authorized parts and service distributors.
 6. Final testing reports.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Security monitoring and control system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. Units and components offered under this Section shall be covered by a 3-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Access control system (ACS):
 - a. Genetec Security Center, Synergis.
 - b. Mercury Security Access Control.
2. ACS server:
 - a. Dell PowerEdge #R710 series server.
 - b. HP ProLiant #DL380 series server.
3. Controller and modules:
 - a. Mercury Security Access Control.
4. Proximity card readers:
 - a. HID MultiClass SE multi-format technology
 - b. Indala Proximity.
 - c. EM Proximity Readers.
5. Door position contact switches:
 - a. Doors:
 - 1) Honeywell #947-45.
 - 2) Magnasphere #HSS-L2C.
 - 3) SECO #SM-4105.

4) Sentrol #1076D.

- b. Roll-up Doors:
 - 1) Magnasphere #MSS-105S.
 - 2) SECO #SM-226R.
 - 3) Sentrol #1949-L, floor mount.
 - 4) Sentrol #1912-L, aluminum L-bracket.
6. Access control cards:
 - a. HID iCLASS #202x smart cards.
7. Request to exit modules:
 - a. Bosch #DS160 with TP160 trim.

- b. Honeywell #IS320WH with IS310WHTP trim.
- 8. Power supplies and battery chargers:
 - a. LifeSafety Power MCLASS, Dual Voltage series.
- 9. Batteries:
 - a. Interstate Batteries #SLA1105 sealed lead acid series.
 - b. Yuasa Battery Inc. #RE12-12 sealed lead acid series.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 ACCESS CONTROL SYSTEM (ACS) SERVER OVERVIEW

- A. System description:
 - 1. The ACS server shall be IT standards compliant and fully featured solution.
 - 2. The ACS shall be available in hardware and software bundled as a true network, so that all applications are pre-installed, enabling the system to run almost immediately with minimal configuration required.
 - 3. The ACS server shall be built on a hardened Linux network using LDAP compliant directory structure.
 - 4. The ACS shall support updates for:
 - a. Software maintenance of operating system service packs.
 - b. License seats.
 - c. Virus control.
 - 5. The ACS server shall utilize industry standard TCP/IP network infrastructures to communicate including, but not limited to:
 - a. All ACS field devices.
 - b. Intelligent field hardware controllers.
 - c. Browser based workstation.
 - 6. The ACS server shall be comprised of industry standard pre-installed components including:
 - a. An embedded Linux operating system utilizing an open source kernel.
 - b. An open LDAP directory structure for identifying data storage.
 - c. A NGINX web server.
 - d. ACS software.
 - 7. All setup, maintenance, and interaction with the system shall be accomplished with no interaction with the operating system or directory structure.
 - 8. The ACS server shall act as the central repository for all system configuration and activity.
 - a. Interfacing with the ACS server shall be via a web browser only.

- b. A separate database server with a unique operating system or a database server shall not be acceptable.
- 9. The ACS server shall provide browser-based accessibility to all applications, without the mandated requirement of a dedicated client workstation. The following industry standard web browsers shall be supported:
 - a. Mozilla Firefox.
 - b. Google Chrome.
 - c. Apple Safari.
 - d. Internet Explorer.
- 10. The ACS server shall support industry standard field hardware platforms, including but not limited to:
 - a. Mercury Security's access control product line.
 - b. HID control product line.
 - c. Wired Locks.
- 11. The ACS server shall be hardened to safely secure all communications and data.
 - a. Data communicated over the network to and from the ACS server, and the web browser workstations, shall be secured via SSL 128-bit encryption.
 - b. ACS server backups shall be encrypted using AES encryption.
 - c. ACS server shall back up to:
 - 1) USB storage device.
 - 2) Windows shared directory or network shared folder.
 - 3) Secured SCP servers.
 - d. All passwords required to log in to the ACS server shall be encrypted within the open LDAP directory structure.
- 12. The ACS server architecture shall enable distributed decision-making at the intelligent field hardware controllers.
 - a. The ACS server architecture shall enable complete functionality during periods where communication is lost between a server and its associated intelligent field hardware controllers.
 - b. During downtime, the intelligent field hardware controllers shall maintain an audit log of all activity that occurred and shall upload this data to the ACS server once normal communications are restored.
- 13. The ACS server architecture shall provide scalability to support the addition of:
 - a. Card readers and/or input/output points.
 - b. Additional ACS controllers.
 - c. Intelligent field hardware controllers.
- 14. When multiple ACS servers are deployed, the ACS shall support automated grid-based replication of the ACS directory. The replication architecture shall:

- a. Be peer-to-peer.
 - b. Not require a dedicated central database server.
 - c. Enable replication of identities and configuration across ACS servers.
15. The ACS shall support a hot standby, auto-failover architecture. Should a primary ACS server fail to function, a second ACS server, assigned to act as the backup to the primary, shall automatically detect a problem and assume system control.
16. The ACS shall support integration with 3rd party subsystems through use of its collaboration interface. These systems shall include, but not be limited to:
- a. Integrated access management (IAM) systems.
 - b. Security information and event management (SIEM) systems.
 - c. 3rd party IT and business systems, including but not limited to:
 - 1) Systems that utilize Oracle RDBMS as their data engine.
 - 2) Systems that utilize Microsoft SQL Server as their data engine.
 - d. The ACS shall be able to pull information into its directory structure and push events out to third-party systems.
17. The ACS shall provide single software-based license key that resides on each ACS server to control licensed features and/or components.
- a. Software licenses shall be upgradable and/or amendable via email or download from manufacturer secured web site.
 - b. The ACS server shall support a minimum of 50 concurrent client connections. Individual license keys for traditional client workstations and/or physical hardware license keys shall not be acceptable.
18. The ACS server shall support seamless, forward compatible upgrades of the ACS application software.
- a. All systems of the same generation shall be upward compatible.
 - b. Access control field hardware devices shall not have to be replaced as the system grows to larger levels.

2.03 ACCESS CONTROL SYSTEM (ACS) SERVER HARDWARE

A. ACS server:

- 1. The hardware platform shall consist of a 1U, short depth, rack-mount unit meeting the following minimum specifications:
 - a. CPU: Intel Quad Core 3.1 GHz 8M Cache
 - b. Memory: 4GB, 1600Mhz
 - c. Network interface: Minimum of 2 x 1GbE per port
 - d. OS compatibility: Linux Hardened Virtual Server
 - e. 1TB: 7200 RPM disc for OS/server and storage
- 2. ACS server capacities:

- a. Doors: 2048.
 - b. Alarm input points: 5,060.
 - c. Relay output points: 5060.
 - d. Card holder identities: 500,000.
 - e. Concurrent WEB client connections: 50.
 - f. On-line event history log: 150,000,000.
3. Rack drawer:
- a. The rack drawer shall be an integrated system including keyboard, mouse, monitor, 1x switch, and connecting cords, all in a 1U slide-out drawer package.
 - b. Keyboard: 104-key with separate numeric keypad.
 - c. Mouse: 2-button Trackball mouse.
 - d. Monitor: 19" TFT/LCD high resolution (1280 x 1024, minimum) monitor, VGA or DVI.
 - e. Integrated DVI/USB/audio 1x8 switch.

2.04 ACCESS CONTROL SYSTEM (ACS) SERVER SOFTWARE

- A. Alarm monitoring functionality:
- 1. Alarm and event attributes shall allow administrators to configure how each alarm and event is communicated in the alarm monitors:
 - a. The event listing window shall list all alarms and events with their associated event type and the source object that is responsible for generating the alarm or event.
 - b. Upon logging in and accessing the alarm monitor, all queued alarms and events shall report into the alarm monitor for operator action.
 - 2. For each alarm and event in the system, administrators shall have the option to:
 - a. Rename the alarm or event from its factory default.
 - b. Rename, where applicable, the return to normal state name for the alarm or event.
 - c. Assign an event type that shall set the default configuration for the alarm or event.
 - d. Display the alarm or event in the alarm monitor.
 - e. Mask the alarm or event from displaying in the alarm monitor.
 - f. Display text instructions that shall guide the operator in responding to the alarm.
 - g. Automatically send an email message to a recipient.
 - h. Have the alarm display in priority order based on the priority of the alarm. A minimum of 99 priorities shall be supported.

- i. Set the priority of the alarm or event, as well as its associated return to normal event priority.
- j. For video related alarms or events, automatically launch the video player to display a live video feed from the camera associated with the device that generated the alarm or event.
- k. Store the alarm or event information for later retrieval.
- l. Create distinct schedules that shall be able to be assigned to different alarm types.
- m. Create a schedule to enable/disable global events, which should include, but not be limited to:
 - 1) Shunt/un-shunt doors.
 - 2) Mass denial of credentials (lock down).
3. Alarm and event logging: All alarms and events in the ACS shall log by default to the ACS server internal data storage logging structure.
4. Off-line alarm/event shall queue alarms and events that occur:
 - a. While the alarm monitor is off-line with the rest of the system.
 - b. When an operator is not logged in to the alarm monitor.
5. Alarm and event types shall support creation of alarm and event types:
 - a. Alarm and event templates shall be created as part of the installation.
 - b. Event types shall contain configuration of parameters including, but not limited to:
 - 1) Priority.
 - 2) Text instructions.
 - 3) Masking and masking schedule.
 - 4) Logging.
 - 5) Reporting.
 - 6) Email notifications.
 - c. Each alarm and event type shall be able to support multiple alarm and event assignments.
6. Alarm/event synchronization: The ACS shall support alarm synchronization for alarm and events that report into multiple alarm monitors. When an alarm or event is acknowledged or cleared by an alarm monitor operator, it shall be cleared from all other alarm monitors.
7. Alarm reporting based on schedule: The ACS shall support the reporting of alarms to alarm monitors based on schedules. Each alarm in the system shall have the ability to have its own associated schedule.
8. Alarm/event text instructions: The ACS shall allow each alarm and event in the system to have associated text instructions. Text instructions shall be able to contain a minimum of 200,000 characters.

B. Access control functionality:

1. Access groups shall consist of the following:
 - a. Access groups of any number of card readers in the system assigned to a single schedule.
 - b. Any card reader shall have the ability to belong to any access group and a card reader shall have the ability to belong to multiple access groups.
 - c. The ACS shall allow credential holder access to secure areas based on:
 - 1) Card reader.
 - 2) Time.
 - 3) Day.
 - d. The ACS shall support a minimum of:
 - 1) 255 access groups per intelligent controller
 - 2) Access groups can be assigned to an individual credential holder per intelligent controller and shall optionally be selectable up to 16 total.
 - e. Access groups shall support conventional names up to 50 alphanumeric characters.
2. The ACS shall support the creation of schedules:
 - a. Schedules shall serve as templates for application parameters including, but not limited to:
 - 1) Access groups.
 - 2) Masking devices.
 - 3) Device modes.
 - b. The ACS shall support a minimum of 255 schedules. Each schedule shall be set to one of 3 operating modes:
 - 1) On: The schedule is active 24-hours per day/7-days per week.
 - 2) Off: The schedule is never active.
 - 3) Scan: The schedule is active during the assigned intervals.
 - c. Each schedule shall have the ability to be assigned a predetermined interval:
 - 1) Each interval shall have the ability to be assigned to any day(s) of the week.
 - 2) Shall be assigned to function on up to 8 holiday types.
 - 3) Up to 10 intervals shall be supported.
 - d. Schedules shall be downloaded to all related intelligent controllers for local processing and decision making.
 - e. Schedules shall support conventional names up to 50 alphanumeric characters.
3. Holidays shall allow specific dates and/or ranges to be defined as a holiday:

- a. The ACS shall support a minimum of 255 holidays.
 - b. A holiday shall have the ability to be assigned up to eight (8) different holiday types.
 - c. The following parameters of the ACS can be temporarily altered, adjusted, or suspended, including, but not limited to:
 - 1) Card reader modes.
 - 2) An identity access rights.
 - 3) Masking schedules.
 - d. The ACS shall support an embedded calendar to assist in configuration of holidays.
 - e. Holidays shall support conventional names up to 50 alphanumeric characters.
4. Card reader shall allow the following options to be defined for card readers in the system:
- a. Specify the card reader is an active card reader.
 - b. Specify the off-line mode operations should the card reader lose communications with the intelligent controller/intelligent field controller.
 - c. Specify door forced filter shall reduce false alarms for doors that "bounced." Opening the door within 3-seconds of the door closing shall not report a door forced open alarm.
 - d. Extended cardholder door held open time shall allow a card reader's door held-open time to be extended beyond the normal configured time:
 - 1) The extended door held open time shall be definable up to 32,767-seconds.
 - 2) ACS shall be able to define application of this functionality by:
 - a) Card reader.
 - b) Credential holder.
 - e. Duress access to a card reader shall support a duress mode for a credential holder's entry through a card reader:
 - 1) When a credential holder is gaining entry under duress, they shall append the number "5" to the end of their PIN code. A credential holder with PIN of 9999 would enter 99995 when entering an area under duress.
 - 2) Duress access shall be made for card readers in:
 - a) Card and PIN mode.
 - b) Card or PIN mode.
 - c) PIN mode only.
 - 3) Upon entrance to a card reader under duress, an alarm shall be sent to the alarm monitor and logged to the audit database.

- 4) The ACS shall be capable of denying a credential holder access to the card reader during duress, even if that credential holder entered the proper duress code. An alarm shall generate at the Alarm Monitor noting duress access was requested and denied.
- f. Specify strike node or strike operations allowing administrators to define, upon a valid access:
 - 1) Door strike remains active for the entire strike time.
 - 2) Door strike turns off after the door has closed.
 - 3) Door strike deactivates as soon as the door is open.
 - 4) Do not pulse door strike on rex as door strike disabled during a valid request to exit.
 - 5) The ACS shall allow a card reader's strike to be extended beyond the normal strike time for specific individual credential holders:
 - a) The extended strike time shall be definable up to 255 seconds.
 - b) The extended strike time shall be definable by card reader.
 - c) The extended strike time shall be definable by credential holder.
- g. Log all access as used in instances where there is not a door contact at the door to monitor door position, the ACS shall assume entry and report an event into the alarm monitor.
- h. Do not log rex (request to exit) transactions to the directory structure.
- i. Two-card control shall require that two valid access requests occur prior to granting access to the door:
 - 1) Both requests must occur within a 10-second period.
 - 2) In the event a second valid access has not occurred within 10-seconds of the first valid access request, the card reader shall reset, and the first credential shall have to be presented again.
- j. Activate Schedule shall allow administrators to activate outputs attached to the card reader on a scheduled basis. Whether a card reader is part of an anti-passback area and if so, it is related configuration.
- k. Use shunt relay shall have the ability to shunt a door contact of separate intrusion detection systems:
 - 1) When the ACS provides an access grant, a dedicated auxiliary output shall first trigger and bypass the door contact of the separate intrusion detection system, and then the door locking mechanism shall unlock.
 - 2) Once the door returns to a secure state, the door contact of the separate intrusion detection system shall return to its normal state.
5. The ACS shall support a door held open pre-alarm capability. When a door has been held open for a pre-determined amount of time after a valid access grant, a local audible annunciation shall alert the credential holder to close the door. Failure to close the door between the pre-alarm annunciation and the configured

door held open time shall generate an alarm at the alarm monitor. Pre-alarm parameters apply to:

- a. Door held open time.
 - b. Pre-alarm time.
 - c. Shall be configurable up to 65,534-seconds.
 - d. Pre-alarm setting shall be distinct for each door.
6. The ACS shall support the ability for card reader modes to be overridden from the standard mode on a scheduled basis. Based on the card reader type, custom modes shall include:
- a. Card only.
 - b. Card and PIN.
 - c. Card or PIN.
 - d. Locked.
 - e. Unlocked.
 - f. Facility code.
 - g. At the end of the scheduled override, the card reader shall return to its default standard mode.
7. The ACS shall support cipher mode, which shall emulate the presenting of a credential to a card reader with a keypad:
- a. In cipher mode, an authorized credential holder shall attempt access by entering their credential ID/card format at the keypad:
 - 1) The card reader shall treat the information as a magnetic card format read.
 - 2) The number sequence must match an existing magnetic card format configured in the system, including facility code.
 - 3) Correct entry of code will allow access.
 - 4) Incorrect entry of code will be ignored and deny access to the card reader.
 - 5) Will not send a transaction to the alarm monitor.
 - b. A card reader in card and PIN mode and cipher mode shall also require that the credential holder's PIN be entered after the original sequence.
8. Changes in card reader mode shall not remove a card reader from cipher recent door transactions. The ACS shall provide a form listing the most recent transaction activity associated with a door, without having to run a report. Information provided shall include:
- a. Transaction activity.
 - b. Time/date.
 - c. Identity.

- d. Token related details.
- 9. The ACS shall support an invalid PIN attempts count on a per card reader basis. Invalid PIN attempts parameters shall include, but not be limited to:
 - a. Unknown PIN entry at a card reader configured as card or PIN mode
 - b. Invalid cipher entry at a card reader in cipher mode
 - c. Invalid PIN entered for a given card at a card reader configured as card and PIN mode.
 - d. The denied PIN attempts value shall be configurable from 0 to 255.
 - e. The following events shall cause the counter to reset to zero:
 - 1) X (user defined) minutes pass without any of the above denial types.
 - 2) An access grant at the given card reader.
 - f. When the current deny count reaches the threshold configured for the card reader, a deny count exceeded transaction shall be reported:
 - 1) This transaction shall only be reported when the limit is initially reached.
 - 2) It shall not report on subsequent denials.
 - g. Define the number of invalid PIN attempts may be presented before generating an alarm to the alarm monitor.
- 10. The ACS shall support macro/trigger functionality when the deny count exceeded transaction occurs. Actions shall include, but not be limited to:
 - a. Lock down the card reader.
 - b. Annunciating a local siren.
 - c. Shall be configured to execute for a given card reader.
 - d. Multiple complementary modes can be assigned per reader.
- 11. Buttons in the graphical user interface (GUI) shall be available to control the operational state of the door including:
 - a. Disable.
 - b. Lock.
 - c. Unlock.
 - d. Grant.
 - e. Restore.
 - f. Mask held.
 - g. Unmask held.
 - h. Mask forced.
 - i. Unmask forced.
 - j. Mode.

12. The ACS shall support a door summary and status page that shall display a list of all doors defined in the system. For each door in the system, the door summary and status page shall display:
 - a. Door name
 - b. Current door mode
13. Door status including forced and held states, masking states, as well as communications and tamper states.
14. Results displayed are capable of being filtered by door group or by other searchable criteria:
 - a. Mask alarm filters shall filter alarms displayed on the workstation GUI.
 - b. Filter operator views to remove door forced open and door held open alarms to:
 - 1) Mask permanently
 - 2) Mask during a schedule
 - c. Distinct schedules shall be able to be assigned to different alarm types.
15. The ACS intelligent field controller and card readers shall all support a minimum of 8 card formats, including but not limited to:
 - a. Wiegand.
 - b. Magnetic Stripe.
 - c. The ACS shall support any industry standard format that uses:
 - 1) Card numbers.
 - 2) Facility codes.
 - 3) An issue code combination.
 - d. The ACS shall support:
 - 1) A maximum nineteen (19) digit card number.
 - 2) Two-digit issue codes.
16. The ACS shall support the hub from ASSA ABLOY, allowing connectivity to wireless readers.
17. The ACS shall allow administrators to define configurations to be assigned to alarm inputs for use with end-of-line resistance configurations:
 - a. Standard end-of-line resistance configurations shall include:
 - 1) Independently define request to exit and door contacts as normally open or normally closed.
 - 2) Independently define request to exit and door contacts as supervised or unsupervised.
 - b. Additionally, a minimum of 4 custom end-of-line resistance configurations shall be available.

- c. Configurations shall be given a priority of low, medium, or high.
 - d. Configurations shall include options for low range and high range resistance thresholds.
 - e. Configuration options shall include the following input line statuses:
 - 1) Inactive.
 - 2) Active.
 - 3) Ground fault.
 - 4) Open.
 - 5) Short.
 - 6) Foreign.
 - 7) Non-setting.
18. The ACS provide elevator control:
- a. Using standard access control field hardware.
 - b. Permits the restriction of access to certain floors.
 - c. Shall not restrict access to general admittance floors.
 - d. Card readers shall be located in the cab of the elevator.
 - 1) Shall be able to control access for a minimum of 1-floor.
 - 2) Shall integrate to Input and Output Control Modules.
 - 3) Shall restrict which floor select buttons are accessible when a credential is swiped based on the identity access level.
 - 4) Shall permit only one authorized floor to be selected per single card swipe.
 - 5) Shall not require a swipe by any passenger to access floors programmed as public access.
19. Individual floors shall be configurable independently to allow visitor/general access to different floors during different times of the day.
20. The ACS shall be able to track which floor was selected by an individual cardholder for auditing and reporting purposes.
21. Anti-passback:
- a. The ACS shall provide area control features including, but not limited to:
 - 1) Hard anti-passback.
 - 2) Soft anti-passback.
 - 3) Timed anti-passback.
 - 4) Two-person control.
 - 5) Occupancy count.
 - 6) A minimum of 127 areas shall be able to be created per ACS server.

- b. In addition to functions specific to hard or soft anti-passback, either function shall include, but not be limited to:
- 1) Initially (time 0) all credential holders are reset to area 0.
 - 2) Any credential holder shall enter a controlled area any time after time 0 by presenting a token to an entry card reader.
 - 3) A credential holder shall not exit the controlled area unless he/she has entered the area presenting a token to the area entry card reader.
 - 4) A credential holder shall not enter the controlled area a second time unless the credential holder has exited that area previously.
 - 5) A credential holder shall be able to enter through any entry card reader and exit through any exit card reader of a single controlled area.
 - 6) A forgiveness feature that shall allow the administrator to give credential holders one free pass to allow the ACS to move them into the next area they enter, regardless of their current anti-passback status.
 - 7) One free pass shall be given to an individual credential holder, to all credential holders in a single enterprise intelligent field controller, or to all credential holders in the ACS.
 - 8) The ACS shall provide an anti-passback exempt option for privileged or VIP credential holders. Credential holders with this option will not have anti-passback rules applied to them.
 - 9) An area shall have the ability to be disabled/closed that shall not allow any access into the area except for those tokens with APB privileged status.
- c. Hard anti-passback (APB)
- 1) Shall require that a token always be used to enter and exit an area.
 - 2) The controlled areas shall have both entry and exit card readers at all portals.
 - 3) Entry and exit readers shall be confined to a single intelligent field controller.
 - 4) Areas shall be logically defined.
 - 5) Area control shall not be required to encompass every card reader in the system.
 - 6) Shall work in the following manner:
 - a) Once in an area, a credential holder must present their token at an exit card reader of the area they are currently in and wish to leave.
 - b) Once access has been granted to leave the area and enter a new area, the credential holder must present their token at an exit card reader of the new area.
 - c) Should a credential holder present their token at any other card reader involved in area APB, the credential holder shall be denied access and an alarm shall be reported.

- 7) Nested control areas (areas inside areas) shall be definable with a minimum of 64 entry and exit card readers. It shall be possible to have an area within an area and/or multiple areas that are independent of each other in which Hard Anti-Passback rules shall apply.
- d. Soft APB shall require that a token be used to enter and exit an area:
 - 1) The controlled areas shall have both entry and exit card readers at all portals.
 - 2) Entry and exit readers shall be confined to a single intelligent field controller.
 - 3) Areas shall be logically defined.
 - 4) Area control shall not be required to encompass every card reader in the system.
 - 5) Shall work in the following manner:
 - a) Once in an area, a credential holder must present their token at the exit card reader of the area they are currently in and wish to leave.
 - b) Once access has been granted to leave the area and enter a new area, the credential holder must present their token at an exit card reader of the new area.
 - c) Should a credential holder attempt this, the credential holder shall be allowed access (if that credential holder has the appropriate access level to access the new area), and an alarm shall be reported.
 - 6) It shall be possible to have an area within an area and/or multiple areas that are independent of each other.
 - e. Timed area APB shall allow an administrator to decide how long after a credential holder has swiped their token that they will have to wait before the same token will be accepted again at the same card reader:
 - 1) If a credential holder swipes their token a second time after initial entry and after the delay time has expired, access shall be granted, and an APB alarm shall be reported into the alarm monitor.
 - 2) Administrators shall be able to set the delay time up to 65,535-seconds.
 - f. Two-person control shall be provided to restrict access to certain areas unless there are two (2) credential holders present. When an area is configured for two-person control, the following criteria shall prevail:
 - 1) The card reader shall grant access only if two valid credential holders (with authorized access privileges) swipe their badges one after the other. If a second authorized badge is not presented within 10-seconds of the first authorized badge, the card reader shall reset, and the first card will have to be swiped again.
 - 2) Once 2 people occupy an area, individual access shall be granted.
 - 3) Individual exit shall be permitted when an area is occupied by only 2 credential holders at which point the two-person control applies for exit,

meaning both credential holders must present their cards at the exit reader within 10-second of each other and exit together.

22. Occupancy count/control shall restrict the number of credential holders that shall be present in an area at any given time:
 - a. The occupancy-controlled area shall be able to be defined by the administrator to limit up to 250,000 credential holders to be in that area at any given time.
 - b. Once the occupancy limit has been reached, a credential holder must swipe out of the exit card reader before the next credential holder may enter.
 - c. Each area for which occupancy control is enabled shall be definable with up to 64 entry/exit card readers.
 - d. Multiple occupancy-controlled areas shall be definable.
23. Custom device mappings/local alarms shall give administrators the ability to assign a unique group of alarm attributes to specific device-alarm combinations to override the global settings for generic attributes. Administrators may assign a different set of attributes to be applied to a forced door at a research lab than they would for a forced door at a perimeter location.
24. Administrators shall have the ability to set up entry/exit delays for inputs that are attached to any input control module, single reader interface module, or dual reader interface module:
 - a. Administrators shall have three options for entry/exit delay:
 - 1) Administrators shall have the ability to set an input to non-latched entry. When non-latched entry mode is selected and an entry delay is specified, the following procedure ensues:
 - a) When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported.
 - b) If the input is not active when the entry delay expires, then the alarm will not report.
 - 2) Administrators shall have the ability to set an input to latched entry. When latched mode is selected and an entry delay is specified, the following procedure ensues:
 - a) When an input activates, the alarm will not be reported until the entry delay expires.
 - b) If the alarm has not been masked by the time the entry delay expires, the alarm will be reported.
 - c) If the input has been masked when the entry delay expires, then the alarm will not report.
 - 3) Administrators shall have the ability to set an input to exit delay that activates directly after an input has been unmasked. When an exit delay is specified, the following procedure ensues:

- a) When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires.
 - b) If the input is still active when the exit delay expires, the alarm will be reported.
 - c) If the input is not active when the exit delay expires, the alarm will not be reported. This is useful to secure a door when an individual is leaving.
 - b. The ACS shall support a minimum of 65,535-seconds for entry and exit delays.
25. The ACS shall allow the following options to be defined for inputs or outputs in the input control module:
- a. Debounce time shall allow administrators to control the time that an input state change must remain consistent for it to be considered a real change of state.
 - b. End-of-line resistance shall give administrators the option to define an input as normally open or normally closed and define an input as supervised or unsupervised.
 - c. Hold time shall be the amount of time in seconds to wait to report an input activation as restored when an input goes active and then is restored. The hold time shall be configurable from 0-15 seconds.
 - d. Alarm masking shall allow the input to be masked either all the time or during a defined schedule.
 - e. Activate output shall allow administrators to configure an output to activate all the time or during a defined schedule.
 - f. Installed shall define whether the ACS shall consider the input an active component of the on-line system.
 - g. Logging shall allow administrators to determine whether to log all change of state events or only when the event is not masked.
26. The ACS shall allow the following options to be defined for outputs in the relay output control module:
- a. Installed shall define whether the ACS shall consider the output an active component of the on-line system.
 - b. Relay output mode shall set the default mode of the relay output.
 - c. Pulse time shall define how long the output shall pulse when the command is given.
 - d. Schedule shall define the time the relay output is active.
27. The ACS shall support input/output/event linkage, whereby an input/output/event in an intelligent field controller can trigger an action within the same intelligent field controller:
- a. All linkage decisions shall be made local to the intelligent controller.

- b. Administrators shall be able to create macros, each consisting of a sequence of actions to be performed, such as changing card reader modes and activating outputs.
 - c. Each macro shall include up to 30 actions.
 - d. Administrators shall then be able to link events to the macros such that a particular action will trigger a macro to execute.
28. The ACS shall provide administrators the ability to create action groups that may include multiple actions associated with a single event.
- a. Identity filters shall be available to allow activity from specific identities to trigger an action.
 - b. Additional filters shall be applied so that an event input can be filtered to a specific hardware device and/or a specific credential holder token ID.
29. Inputs shall include any enterprise intelligent field controller level event, including but not limited to:
- a. Intelligent field controller events:
 - 1) Cabinet tamper.
 - 2) Power failure.
 - b. Input control module events:
 - 1) Communication loss.
 - 2) Cabinet tamper.
 - 3) Power failure.
 - 4) Input points.
 - c. Card reader events:
 - 1) Cabinet tamper.
 - 2) Communication loss.
 - 3) Door contact tamper.
 - 4) Door forced open.
 - 5) Door held open.
 - 6) Power failure.
 - 7) Card reader tamper.
30. Macro actions shall include, but not be limited to:
- a. Activating an output control module output.
 - b. Masking/unmasking an alarm input.
 - c. Setting the active mode of a card reader.
 - d. Activating/deactivating a schedule.

31. Macros shall be linked to devices and types of inputs shall include, but not be limited to:

a. Intelligent field controller events:

- 1) Cabinet tamper, power failure.
- 2) Secure.
- 3) Fault.
- 4) Alarm.

b. Card reader events:

- 1) Communication status.
- 2) Cabinet tamper, power failure, reader tamper, forced open, held open, door contact tamper, auxiliary input #1, auxiliary input #2.
- 3) Secure.
- 4) Fault.
- 5) Alarm.
- 6) Access activity.
- 7) Access granted.
- 8) Access denied.
- 9) Duress.

c. Input control module events:

- 1) Communications status.
- 2) Alarms: Cabinet tamper, power failure, alarm inputs.
- 3) Secure.
- 4) Fault.
- 5) Alarm.

d. An input/event may trigger multiple macros and a macro shall have the ability to be triggered by multiple inputs/events.

e. The ACS shall support a minimum of 100 macros per intelligent field controller. Each macro shall support a minimum of 30 actions.

C. Identity management functionality:

1. The ACS shall offer an integrated identity management and enrollment functionality as part of the core system functionality. The identity management and enrollment module of the application shall not be written by a 3rd party source.
2. The ACS shall have the ability to import identity records and their associated image in a standard JPEG format. Identity records shall be able to be pre-loaded prior to implementation or added at any time after deployment.

3. The ACS shall provide a pre-configured one-time import utility, using standard comma separated value (.csv) files that shall allow the import of identity information based on the factory shipped data fields.
4. The ACS shall allow individual enrollment of identities. Each identity shall allow entry of required and optional fields. For identities that have access to the ACS application, the following security parameters must be defined during the enrollment process:
 - a. User account.
 - b. Account password.
 - c. Non-activity timeout.
5. The ACS shall use role base permissions. Roles shall be assigned during enrollment. Identity's role shall determine their access groups:
 - a. Which card readers they have access to.
 - b. Which times access to those card readers is allowed.
6. A token shall be created and assigned during enrollment:
 - a. For each token, credentials shall include, but not be limited to:
 - 1) A Badge ID.
 - 2) A minimum of a 19-digit badge ID shall be supported.
 - 3) Embossed number as required.
 - 4) PIN code shall be assigned as required.
 - 5) Activation and deactivation date.
 - 6) Associated settings for anti-passback as required.
 - b. Optional credential parameters shall include, but not be limited to:
 - 1) Adding a token to a group during enrollment.
 - 2) A group may have pre-defined role and policy settings that will drive the configuration of the identity information.
 - 3) Expiration of the credential due to non-use. The credential can be set to expire if not used within a certain timeframe. The parameters shall include, but not be limited to:
 - a) System wide for every credential.
 - b) Variable parameters per individual or access level.
 - c) Individual or access levels can be exempt from expiration.
 - d) Scheduled time for expiration does to non-use shall be at least 1-year from date of activation.
7. During enrollment, the identity's image shall be captured or loaded in from a JPEG file format and a badge template shall be assigned.
8. The ACS shall enable FIPS-201 compliant validation and registration of identities through:

- a. Integration with HID pivCLASS.
 - b. HID pivCLASS certificate manager and updating an existing cardholder record or inserting one if one did not already exist.
 - c. Shall support the import of the photograph and fingerprint biometric from the government issued smart card that is compliant with FIPS-201.
9. The ACS shall allow credential suspension if the card certificate serial number is on a designated list, including, but not limited to:
 - a. Certificate revocation list (CRL)
 - b. If the FASC-N is on TSA canceled card list (CCL).
10. The ACS shall support PIV, TWIC, CAC, and FRAC credentials.
11. Credential re-issuance:
 - a. The operator shall be able to deactivate the existing credential by marking it:
 - 1) Lost.
 - 2) Stolen.
 - b. The ACS shall be able to use the existing Identity information and photo for the new credential. The process shall not require re-enrollment of the credential holder.
 - c. The re-issuance process shall automatically:
 - 1) Remove access rights from the deactivated token.
 - 2) Enable those same rights in the new token.
 - 3) Automatically send the appropriate changes to the intelligent enterprise controllers.
12. Each identity shall have a unique record in the open LDAP directory structure. LDAP directory structure must include the use and definition of user defined fields and forms.
13. Highest level administrators shall be given the ability to delete identities. Bulk delete identities is the ability to delete a group of identities, based on a user defined search set.
14. The ACS shall allow administrators to assign access groups to roles. A Role shall then be assigned to an identity during enrollment. Each identity may have up to 8 access groups assigned to their record per intelligent controller through the assignment of one or more roles to their record.
15. Access group modifications or assignments shall be automatically downloaded to the appropriate intelligent controllers without operator intervention. Completed as a push communication immediately after an identity record is saved. Scheduled, batch updated are not accepted.
16. The ACS shall support an access group view form that allows operators to view:
 - a. All roles that have been assigned to an identity.
 - b. Which access groups are associated with the role.

- c. What doors an identity has access to.
17. The ACS shall support a role-based permission methodology to be used in conjunction with identities:
- a. Roles shall be assigned to identities to determine door access as well as access into the system application.
 - b. Multiple roles shall be able to be assigned to an identity:
 - 1) A parent/child relationship can be defined, per role.
 - 2) Duplicating role information for multiple roles shall not be required.
 - c. Identities shall aggregate all role assigned permissions.
 - d. Each role shall have a defined start and stop date:
 - 1) To allow assignment of roles on a temporary basis.
 - 2) Roles can be manually activated or deactivated through the use of a checkbox.
 - e. Each role shall consist of any combination of the following components that shall determine which roles an operator shall be able to assign to other identities during enrollment:
 - 1) Access groups.
 - 2) Delegation assignments.
 - 3) Role assignments.
18. The ACS shall support IP-based cameras for image capture device:
- a. The operator shall be able to view a live image on screen of the identity to move them into a proper pose or position prior to freezing the image.
 - b. If the operator is not satisfied with the captured image, they shall be able to revert to a live view and freeze a new image.
 - c. Configuration settings for IP cameras, as well as viewing a live and still image of a person shall be user configurable.
19. The JPEG ACS shall support photo capture through use of an IP-based camera:
- a. The operator shall be able to view a live image on screen of the identity to move them into a proper pose or position and then be able to freeze the image.
 - b. If the operator is not satisfied with the captured image, they shall be able to revert to a live view and freeze a new image.
20. Additionally, and optionally, the ACS shall support the ability to import industry standard JPEG photos from digital cameras or other image capture sources.
21. The ACS shall allow the captured photo to be cropped via use of the mouse to define the crop window. Only information inside the crop window shall be saved and stored in the directory structure. Images shall be associated with the Identity and shall be stored in the open LDAP directory.
22. The ACS shall support activation and deactivation dates for all tokens created:

- a. A token shall have the ability to be configured to activate at a future date from time of creation.
 - b. When a token reaches its deactivation date/time, the ACS shall automatically deactivate the access rights associated with the token.
 - c. All access rights of a token shall be eliminated after the deactivation date.
 - d. Should the identity become authorized for access again, new access rights shall be applicable to the same token, and re-issue shall not be required.
 - e. Expiration of the credential due to non-use. The credential can be set to expire if not used within a certain timeframe. The parameters shall include, but not be limited to:
 - 1) System wide for every credential.
 - 2) Variable parameters per individual or access level.
 - 3) Individual or access levels can be exempt from expiration.
 - 4) Scheduled time for expiration due to non-use shall be at least 1-year from date of activation.
23. The ACS shall keep an on-line record of all tokens issued to an identity. For each record, details will be recorded including activation and deactivation dates, token status, and token ID.
24. The ACS shall support a minimum of a 2-digit issue code.
25. The ACS shall support up to 8-digit PIN codes:
- a. Each credential holder in the ACS shall have the ability to choose a PIN to be associated with their record.
 - b. A credential holder's PIN shall have the ability to be changed should the original PIN code be compromised.
 - c. An identity shall be able to be exempted from PIN requirements within the system.
26. The ACS shall support industry standard pre-encoded physical credential options including:
- a. Composite credentials such as PVC cards.
 - b. Proximity credentials including dual PVC technology that includes both proximity and magnetic stripe technology.
 - c. Contact smart credentials.
 - d. MiFare credentials.
 - e. DESFIRE credentials.
 - f. HID multiclass credentials.
27. A credential holder's last entry point:
- a. Shall be displayed on the main identity form.
 - b. Along with a date/time stamp for when entry occurred.

- c. If a credential holder has multiple tokens, the tokens form shall also show the last entry point with date/time stamp for each token in a credential holder's possession.
28. The ACS shall display the date and time of the last modification to that identity record from the main identity form.
29. The ACS shall allow identities to have multiple active tokens associated with their record. A minimum of 25 active tokens may be assigned to an identity.
30. The ACS shall allow for printing on both sides of a credential.
31. The ACS shall allow operators to revoke access privileges from a credential holder by updating that credential holder's token status. A token with revoked access shall immediately stop functioning at all card readers.
32. The ACS shall have the ability to search identities by:
- a. First name.
 - b. Last name.
 - c. Identity.
 - d. Token field in the system.
33. The ACS shall allow multiple field-based identity/token searches using and/or logic. Filters shall include, but not be limited to:
- a. Equals.
 - b. Starts with.
 - c. Ends with.
 - d. Contains.
34. The ACS shall include a pick list builder that allows administrators to define operator selection options that appear in identity form pick lists. Each pick list shall have an unlimited number of pre-defined selections.
35. The ACS shall support the following:
- a. Standard identity:
 - 1) Last name.
 - 2) First name.
 - 3) Middle name.
 - 4) External system ID.
 - 5) Address.
 - 6) City.
 - 7) State.
 - 8) Zip.
 - 9) Phone.
 - 10) Work phone.

- 11) Email address.
- 12) Title.
- 13) Department.
- 14) Division.
- 15) Site Location.
- 16) Building.
- b. Token fields:
 - 1) Last record modification.
 - 2) Status.
 - 3) Type.
 - 4) Issue date.
 - 5) Login.
 - 6) Password.
 - 7) Password confirmation.
 - 8) Inactivity timer.
 - 9) Last door accessed.
 - 10) Last time accessing last door.
 - 11) Photo.
 - 12) Embossed number.
 - 13) Internal number.
 - 14) PIN.
 - 15) Token status.
 - 16) Issue level.
 - 17) Activate date.
 - 18) Deactivate date.
36. The ACS shall provide a form listing the most recent transaction activity associated with an identity, without having to run a report. Information provided shall include:
 - a. Transaction activity.
 - b. Time/date.
 - c. Related token.
37. The ACS shall support the ability to add additional identity-based forms to support user-defined fields:
 - a. Up to 10 user-defined forms shall be able to be added.

- b. Each user-defined field shall be given a field name/label and be defined as one of the following field types:
 - 1) String.
 - 2) Integer.
 - 3) Boolean.
 - 4) Date.
 - c. Up to 300 user-defined fields shall be available.
 - 38. The ACS shall support a tool to allow for the custom creation of identity/token badge layouts.
 - 39. The ACS shall support any size badge provided the printer used for badge creation supports the desired badge size.
 - 40. The ACS shall allow multiple objects to be configured for a badge layout including:
 - a. Alphanumeric text fields.
 - b. Database fields.
 - c. Photos.
 - d. Identity photos.
 - e. Graphics (i.e., logos).
 - 41. Each text and database field added to the layout shall have the ability to employ the following properties:
 - a. Location of the object.
 - b. Height and width.
 - c. Background color.
 - d. Rotation.
 - e. Typeface of text.
 - f. Size of text.
 - g. Color of text.
 - h. Horizontal and vertical alignment of text.
 - 42. Each photo and graphic field added to the layout shall have the ability to employ the following properties:
 - a. Location of the object.
 - b. Height and width.
 - c. Maintain aspect ratio.
 - d. The ACS badge layout tool shall support a color palette that supports a minimum of 16.7 million colors that can be applied to applicable objects.
- D. Alarm and event monitoring:

1. The ACS shall support a tabbed view for the monitor user interface. The following tabs shall be supported:
 - a. Event monitor shall be used to monitor system level events such as operator activity and field level events.
 - b. Alarm monitor shall be used to monitor field level events such as identity access activity, input alarms, and door alarms as well as system level events configured as alarms.
 - c. Swipe and show verification shall be used to view identity information in real-time as credential holders access specific doors.
 - d. Search shall be used to search for alarm and event transactions currently stored in the ACS.
 - e. Hardware status shall be used to view the real-time status of field hardware devices configured in the system, as well as to manipulate/override those devices.
2. The ACS shall allow administrators to configure how alarms and events annunciate into the alarm monitor. Support audible notification at the workstation when alarms arrive in the system:
 - 1) Users shall have the ability to adjust the configuration and parameters.
 - 2) Administrators shall be able to choose a specific sound to pair with each type of alarm.
3. Each alarm and event shall have the following configuration options:
 - a. Display in the alarm monitor.
 - b. Be masked from displaying in the alarm monitor.
 - c. Allow higher alarms to be displayed on top of the alarm monitor when an operator sorts based on alarm priority.
 - d. Display text instructions that shall guide the operator in alarm response.
 - e. Automatically send an email message to one or more recipients.
 - f. For video-related alarms and events, automatically launch the video player to display a live video feed from the camera that is associated with the generating alarm or event.
4. The ACS Alarm Monitor shall provide a real-time count of all alarms and events in the alarm monitor awaiting operator action.
5. The ACS shall support the following options for handling/responding to alarms and events upon selection:
 - a. Acknowledge the alarm.
 - b. Review text instructions on pre-defined alarm response.
 - c. Enter unlimited notes on reason for alarm and/or action taken in alarm response.
 - d. Review the history of the alarm.

- e. For alarms and events that include a credential holder, call up the identity record of that credential holder.
- f. Clear the alarm:
 - 1) Single operator enabled.
 - 2) Two-person control for clearing alarms shall enforce a policy that the operator clearing and alarm(s) from the alarm monitor cannot be the same operator that previously acknowledged the alarm.
 - 3) Role-based clearing of alarms that shall allow system administrators to assign a role or roles to the alarm.
 - 4) The operator attempting to clear the alarm must be assigned one of the roles that are assigned to the alarm in order for him/her to clear the alarm from the alarm monitor.
- 6. The ACS shall support the ability to manage and handle multiple alarms. Operators shall have the ability to clear or acknowledge all selected alarms in a single action.
- 7. The ACS shall allow Identity-based alarm routing that shall route alarms to specific Identities monitoring the application based on:
 - a. Schedule.
 - b. Event type.
 - c. Device.
- 8. The ACS shall allow masking of specific alarms or alarm types based on pre-defined schedules or via manual overrides:
 - a. Masked alarms shall not report into the alarm monitors.
 - b. Logging the transaction database for reporting and audit trail shall not be affected by masked status.
 - c. An operator shall have the ability to mask or unmask any alarm point in the system based on permissions.
- 9. The ACS shall allow alarms and events to be sorted in the alarm monitor by any of the currently configured viewable columns.
- 10. The ACS shall provide the capability to emphasize alarm priority through the use of colored bars within the alarm monitor screen:
 - a. Each alarm priority shall have its own unique user-defined color assigned to it.
 - b. Color bars shall also have the ability to be assigned to individual alarm priorities or to a range of alarm priorities.
- 11. The ACS shall allow administrators to define which columns are displayed in the alarm monitor. Administrators shall also be able to set the column order of the alarm monitor. Columns available for configuration shall include:
 - a. Time.
 - b. Last access.

- c. Token expire date.
- d. Token issue date.
- e. Panel date.
- f. Priority.
- g. Operator.
- h. Identity first name.
- i. Identity middle initial.
- j. Identity last name.
- k. Card number.
- l. Embossed number.
- m. Message.
- n. Event name/description.
- o. Event type.
- p. Panel.
- q. Source.
- r. Location.
- s. Alternate source.
- t. Input address.
- u. Event address.
- v. Source type.
- w. Flags.
- x. Status.
- y. Issue level.
- z. Role.

12. The ACS shall support integrated email capabilities:

- a. The ACS shall be able to generate an email message to send to one or more recipients upon a generated alarm or event.
- b. The email function shall interface with any email server that uses SMTP as its protocol.

13. The ACS shall support an event monitoring tab that shall be used to monitor system level events such as operator activity:

- a. An operator shall be able to choose which field columns to display and shall be able to place those columns in their order of preference.
- b. The operator shall also be able to sort the events by any currently displayed column in the event monitor.

- c. Administrators shall have the ability to configure the number of recent events to display in the event monitor upon accessing the events tab.
- 14. The ACS shall support a real-time field hardware device status counter displaying a summary of the total number of doors, input points, intelligent enterprise controllers, and sub panels that are active, masked, and off-line.
- 15. The ACS shall support real-time system status that depicts all field hardware devices configured. The real-time system status tab shall list:
 - a. Intelligent controllers.
 - b. Input control modules.
 - c. Alarm inputs.
 - d. Relay outputs.
 - e. Card readers.
 - f. The hardware status shall show the real-time status of all these devices (on-line vs. off-line, alarms activated, masking status, etc.).
- 16. The system status shall include three counters:
 - a. Active counter: A counter of the number of active points.
 - b. Offline counter: A counter of the number of offline devices.
 - c. Masked counter: A counter of the number of masked points.
- 17. The hardware status tab shall display all hardware devices separately in their own row. The following shall exist in the tab:
 - a. Device name.
 - b. Intelligent controller/input control module/output control module name.
 - c. Current device status.
- 18. The ACS shall also allow operators to affect the access mode of card readers, open doors, mask/unmask alarm inputs, and activate/deactivate/pulse an output from the tab. The ACS shall also allow operators to affect the access mode of multiple devices with a single action by selecting multiple devices and then performing the command.
- 19. The ACS shall support integration with life safety power's N1 network module. When configured, the LSP power supply link shall appear in the field hardware device status tab and when the link is clicked, the N1 diagnostic and configuration window shall appear.
- 20. The ACS shall support the ability to call-up the history of an alarm. The history call-up window shall display the associated alarm information including time/date stamp, acknowledgement actions by operators, and entered notes. The operator shall not be required to exit the alarm monitor to access this information and this functionality shall not prevent additional alarm activity from reporting to the alarm monitor.
- 21. The ACS shall support the ability to call up the identity form to display the identity record associated with an alarm. The identity call-up window shall display the

identity's information and photo. The operator shall not be required to exit the alarm monitor to access this information and this functionality shall not prevent additional alarm activity from reporting to the alarm monitor.

22. The ACS shall allow operators to manually control the state of field hardware devices and their input/output points from the alarm monitor:

a. Card readers:

- 1) Manually control reader state or based on current schedule.
- 2) Unlocked.
- 3) Locked.
- 4) Facility code.
- 5) Card only.
- 6) PIN only.
- 7) Card and PIN.
- 8) Pulse the door open.
- 9) Mask/unmask.
- 10) Door forced open/door held open.
- 11) Disable the door.
- 12) Restore the door to correct state.
- 13) Mask and unmask inputs.

b. Outputs:

- 1) Manually control reader state or based on current schedule.
- 2) Turn on.
- 3) Turn off.
- 4) Pulse outputs.

23. Field hardware devices shall be available for operator control from the hardware status tab.

24. The ACS shall utilize a last command wins methodology. For example, if an output is set to off due to a schedule and an operator manually turns it on, then the output will remain on until it is manually turned off or until the next scheduled interval occurs.

25. All manual controls shall be recorded in the operator audit log with the time of the change, operator performing the function, and description of the activity performed.

26. The ACS shall support graphical maps through the import of map backgrounds from standard "off-the-shelf" drawing packages in the formats listed below:

- a. Bitmap (.bmp, .dib).
- b. JPEG (.jpg).

- c. Portable network graphics (.png).
 - d. TIFF (.tif).
 - e. Windows metafile (.wmf, .emf).
 - f. Encapsulated post script (.eps).
27. The ACS administrator shall have the ability to place system icons, including card readers, input & output points, video cameras, and other access control field hardware to indicate their location in the facility.
28. Zoom capabilities shall be available to provide closer or farther views of the area. From the map, operators shall be able to:
- a. Acknowledge an alarm.
 - b. Change the access mode of readers.
 - c. Mask/unmask inputs.
 - d. Pulse, set ON/OFF of relay outputs.
 - e. Launch a video "Window."
29. The alarm monitor shall provide status indicators to display the current status of multiple elements of the ACS including:
- a. Total number of pending unacknowledged alarms and events.
 - b. Status of all field hardware devices (intelligent system controllers, subpanels, card readers, inputs, and outputs) including off-line, active, and masked.
 - c. The hardware status tab will show all devices that are in alarm as well as the on-line /off-line status for all field hardware devices.
30. The ACS shall support swipe and show functionality that allows the display of the credential holder's photo as they swipe their badge through a specified card reader:
- a. Up to four card readers shall be active for swipe and show in each browser window.
 - b. Swipe and show allow operators to verify the credential holder to their photo as they enter a portal.
- E. System configuration and administration:
- 1. The ACS shall track and keep a comprehensive log of all alarm and event activity. All alarms and events that occur shall be logged with the following information:
 - a. Alarm name.
 - b. Time and date stamp.
 - c. Where the alarm occurred.
 - d. Acknowledgement information.
 - e. All operator actions associated with the alarm or event.

2. Administrators shall be able to suppress certain alarms from logging during pre-defined scheduled times of the day.
3. Alarm and event information can be viewed through the ACS reporting engine that shall list the total number of alarms and events that are logged in the ACS server. The number of stored alarms and events shall be limited only by the amount of disk space available in the ACS server.
4. The ACS shall support an auto logout feature that shall allow the system to automatically log an operator out of the system after a period of inactivity. Auto logout timeout choices shall include:
 - a. 10-minutes.
 - b. 15-minutes.
 - c. 30-minutes.
 - d. 60-minutes.
 - e. 1-hour.
 - f. A selection shall be available to not log out an operator regardless of inactivity length.
5. All major ACS features and functions shall be permission protected through the use of delegations:
 - a. Each operator account shall be assigned a role, which shall include a list of delegations assigned to that role.
 - b. Operator access to ACS screens, as well as their ability to view, add, edit, or delete ACS objects shall be controlled through delegations.
6. The ACS shall support a software-based license enforcement model. A hardware key or dongle shall not be acceptable for controlling licensed features and functionality.
7. The ACS shall support the ability to analyze real-time diagnostic information for each ACS server by viewing the about page for the server. Diagnostic data shall include:
 - a. Number of days online.
 - b. Current load.
 - c. Memory.
 - d. Disk space usage.
 - e. Network communications data.
8. The ACS shall support on-line, context sensitive help to assist system users in the operation of the system. Once inside the help program, users shall be able to navigate the help files, moving to other areas of the documentation with having to go back into the application software. The help files shall have a linked table of contents, index, and search capability.
9. The ACS shall support operator accounts:

- a. Each operator account shall require a unique user name password to access the system.
 - b. Each operator account shall also be assigned a role, which shall determine the permission level for that account, thus controlling what functions the operator can perform in the system.
 - c. All modifications to an operator account shall be reported to the event monitor and logged to the LDAP directory structure for audit and reporting processes.
 - d. The ACS shall support as many operator accounts as configured identities.
10. Each operator account shall require a unique user name and password that would tie that identity to delegation rights to access the ACS:
- a. This denotes operator access to:
 - 1) Screens the operator can access.
 - 2) Tasks the operator can perform.
 - b. An operator shall be able to change their ACS password at any time.
 - c. Strong password parameters shall be supported:
 - 1) Requiring system users to enter at least 8-characters.
 - 2) Include at least one upper case letter, one lower case letter and one numeral.
11. The ACS shall support policies that shall act as templates to be applied to field hardware devices in the system to ease in configuration of similar devices. Each Policy shall consist of a template for card readers, inputs, or outputs. The ACS shall support an unlimited number of policies.
12. The ACS shall support grouping of parameters for ease of configuration. Grouping concepts should include, but not be limited to:
- a. Roles.
 - b. Field hardware devices.
 - c. Policies.
13. The ACS shall provide the capability for advanced system partitioning:
- a. Each partition shall be allowed its own group of identities, field hardware, and parameters such as schedules and access groups.
 - b. Identities shall be allowed to belong to one or multiple partitions.
 - c. Partitioning shall provide a flexible “tenant/landlord” architecture whereby partition users can only view, add, modify, and delete identities, system parameters and field hardware that belong to their respective partitions.
 - d. ACS operators may be assigned to more than one partition. A partition may be assigned to more than one operator.
14. The ACS shall track and keep a comprehensive log of all operator account activity. All changes that occur in the directory structure shall be logged including, but not limited to:

- a. Operator account login/logout activity.
 - b. Adding, deleting, or changing identity records.
 - c. Change to system configurations to include, but not limited to field hardware, access groups, or schedules.
 - d. Activity performed inside the alarm and event monitor, include but are not limited to acknowledging alarms, opening doors, or clearing events.
15. The logged activities shall include, but not be limited to:
- a. Operator account.
 - b. Date and time of the activity.
 - c. Activity that was performed.
 - d. Original data prior to change, if applicable.
 - e. New data that was updated.
16. The operator account activity information can be viewed through the ACS reporting engine that shall list the total number of operator events that are logged in the ACS server. The number of stored operator account events shall be limited only by the amount of disk space available in the ACS server.
17. The system scheduling utility shall allow system administrators to schedule actions:
- a. On-demand or single-use.
 - b. Recurring basis.
 - c. The types of actions include, but not limited to running reports, updating identity profiles, apply door modes and running global actions.
 - d. The scheduling utility shall satisfy a wide range of scheduling needs, including, but not limited to:
 - 1) Hourly: i.e., every day on the hour.
 - 2) Specific day, specific time: i.e., every Monday at 8:00 am.
 - 3) Monthly: i.e., the first Sunday of every month.
 - 4) Specific recurring date: i.e., every February 29th @ noon.
 - 5) Specific date in the future: i.e., December 7, 2017 @ 5pm.
 - 6) Recurring activities can be set to.
 - 7) A master start and stop date.
 - 8) Run indefinitely.
18. The scheduling utility shall provide a job monitor allowing the system administrator to:
- a. See the status of currently running tasks.
 - b. See a chronological list of future scheduled tasks.
 - c. See a history log of completed tasks.

19. The ACS shall support a minimum of 23-standard reports:

- a. Reports shall have the ability to be created as either:
 - 1) PDF document.
 - 2) Spreadsheet document.
- b. Once generated, the report can be either:
 - 1) Saved to a file.
 - 2) Printed to a local or networked printer.
- c. Each report shall have the ability to be customized/filtered on relevant data for each report.
- d. Standard ACS reports shall include:
 - 1) The Access Grant Audit Report shall present information on all access grant activity that was manually generated by an operator and shall include the door that was opened, time, and operator executing the door grant.
 - 2) The Access Group Report shall present information on all defined ACS access groups, including but not limited to:
 - a) The roles that are assigned to the group.
 - b) The schedule assigned to the group.
 - c) The number of doors assigned to the group.
 - d) List of the doors assigned to the group.
 - 3) The Alarm Report shall present information on all alarms that occurred in the system including panel name, operator action taken, operator responding to the alarm, and any operator notes pertaining to the alarm.
 - 4) The Gateway Report shall present information on each defined ACS server, including:
 - a) The ACS server type.
 - b) The DNS name and domain.
 - c) The local time zone and daylight savings time settings.
 - d) A list of field hardware manufacturers enabled.
 - e) A list of intelligent controllers configured to report to the panel.
 - 5) The Area Report shall present information on all defined areas. Each area entry shall include area name, ACS server where the area exists, and doors assigned to the area.
 - 6) The Audit Log Report shall present information about each change made to the ACS by an operator. Each audit log entry shall include:
 - a) A date/time stamp.
 - b) Description.

- c) The operator who made the change.
 - d) The type of change.
 - e) The details of the change.
 - f) The original information prior to the change (if any).
- 7) The Camera Report shall present information on each camera configured in the system including camera name and its attributes.
 - 8) The Collaboration Report shall present information on all defined ACS collaboration scripts, including collaboration type and if the collaboration is active.
 - 9) The Delegation Report shall present information on all defined ACS delegation groups, including which identities have been assigned to the delegation and what permission have been configured for that delegation.
 - 10) The Door Access Report shall present information on credential holder access to each door in the ACS, including the schedule that the credential holder can access the door.
 - 11) The Door Configuration Report shall present information on the complete configuration/settings of each door configured in the ACS.
 - 12) The Event Report shall present information on defined events in the system along with their attributes including:
 - a) Event name.
 - b) Assigned event type.
 - c) Priority.
 - d) Masking schedule.
 - e) If the event is configured to always mask and/or log the event.
 - 13) The Event Type Report shall present information on each defined ACS event type, including:
 - a) Suppression schedule.
 - b) Priority.
 - c) Retransmission time.
 - d) Retransmission procedure.
 - e) Procedure.
 - f) If the event type is set to be masked, logged, and/or sent to the alarm monitor.
 - 14) The Group Report shall present information on all defined groups, including group name, type, and members information such as card readers and roles.
 - 15) The Holiday Report shall present information on each defined holiday, including the date of the holiday, number of days the holiday is in effect and the holiday type(s) assigned to the holiday.

- 16) The Identity Access Report shall present information on each defined Identity with respect to which doors they have access. The report shall include the schedule in which access has been granted to each reader as well as the access group and role assignments that allow access to each reader.
- 17) The Identity Summary Report shall present information on each defined identity with respect to identity status and type, token(s) issue and expiration date, and which roles and access groups have been assigned to the identity.
- 18) The Panel Report shall present information on the complete configuration/settings of each intelligent controller configured in the ACS.
- 19) The Policy Report shall present information on all defined policies in the ACS, including:
 - a) Policy name.
 - b) Active status.
 - c) Which hardware components the policy encompasses.
- 20) The Role Report shall present information on each defined role, including:
 - a) Parent information.
 - b) Activation/deactivation dates.
 - c) Child roles.
 - d) Identities assigned to that role.
 - e) Access Groups assigned to that role.
 - f) Doors assigned to that role.
- 21) The Schedule Report shall present information on each defined schedule, including its mode and each interval configured:
 - a) Days of the week.
 - b) Holiday types.
 - c) Start and end times of the interval.
- 22) The token report shall present information on all tokens in the system including token number, identity to whom the token is assigned, and active/de-active status.
- 23) The Transaction Report shall present information on each transaction generated at the field hardware level. Each transaction log event shall include:
 - a) Date/time stamp.
 - b) Event source.
 - c) Event name and type.
 - d) Identity and token information.

- e. The ACS shall support Quick Reports:
 - 1) Each of the standard reports defined in the reports section shall have the ability to have relevant data filters applied to them, prior to running, in order to provide a report with more specific information than the generic report. Quick Report settings shall be designed to run once and shall not be saved.
 - 2) Quick Reports shall have the ability to output their results to a PDF file format or to a spreadsheet file format.
- f. The ACS shall support Custom Reports:
 - 1) Each of the standard reports defined in the reports section shall have the ability to have relevant data filters applied to them, prior to running, in order to provide a report with more specific information than the generic report.
 - 2) Custom Reports shall be designed to run multiple times and shall be saved in the reports form for fast future execution.
 - 3) Custom Reports shall have the ability to output their results to a PDF file format or to a spreadsheet file format.
 - 4) Each Custom Report shall be given a unique name to identify it in the reports list.
- 20. The ACS shall have remote support capability to allow value added reseller or manufacturer to access customer's server for:
 - a. Troubleshooting.
 - b. Diagnostics.
 - c. Load review.
 - d. Assistance with configuration.
- 21. The ACS shall offer the ability to obtain software log data out of the system server logs for further application support.
- 22. The ACS shall support automated grid-based replication architecture of the server directory structure for customers that deploy multiple servers:
 - a. The replication architecture shall be peer-to-peer and not require a dedicated database server to enable replication of identities and configuration data across servers.
 - b. The ACS shall support encrypted communications between servers using SSL encryption.
 - c. Replication shall allow the LDAP data of all servers to be synchronized with each of the others in the system, allowing for the ACS server to rebuild itself from replicated data found on another server found in the system.
- 23. The ACS shall support a hot standby, auto-failover architecture. For each server, a hot standby server shall be configured to monitor the status of its primary partner device. Should a server fail to function, the hot standby server shall be able to automatically detect a problem and assume control of the system.

24. The ACS shall support software updates via downloading from the manufacturer web site or receiving via email the update files. No physical interaction with the ACS server shall be required to perform a successful update or upgrade to the system software.
 25. The ACS shall have the ability to backup and restore the LDAP directory structure. Backups shall run concurrently with the rest of the system and shall not require all operators to log out of the ACS:
 - a. Backups shall include transaction data and system configuration data.
 - b. Server backups be encrypted using AES encryption.
 - c. Server backups to:
 - 1) USB storage device.
 - 2) Windows shared directory or network shared folder.
 - 3) Secured SCP servers.
 - d. Backups shall be performed:
 - 1) Automatically on a predefined daily schedule.
 - 2) Manually via the user interface.
 26. The ACS shall support restart and shutdown capabilities of the server. The ACS user interface shall support both re-start and shutdown of the server. Rights and access to re-start and shutdown of the server shall be denoted by login.
 27. The ACS shall support localized date and time display.
 28. The ACS shall support system data logs to assist with diagnostics and troubleshooting. Standard logs shall include web server logs, field hardware communication logs, system software logs, and system transaction logs. All logs shall be viewable in a plain text format.
- F. 3rd party collaboration:
1. The ACS shall support a collaboration utility that shall allow for real-time or scheduled transfer of information, including images and events, between the ACS and 3rd party IT, security, and other systems.
 2. A user interface shall allow for the generation of import and export collaborations. A start and stop date shall be applied to run the collaboration during the scheduled intervals only between certain dates.
 3. The ACS shall support a minimum of 32-collaborations per ACS server.
 4. The ACS shall support the following collaboration types:
 - a. Identity LDAP pull.
 - b. Identity Oracle RDBMS pull.
 - c. Identity LDAP SQL server pull.
 - d. Events push to ArcSight CEF.
 - e. Events push to Splunk.

- f. Events push to Syslog.
 - g. Events push to SNMP.
 - h. Events push to Milestone Video.
 - i. One time import of identity records using factory shipped fields.
5. Identity pull collaborations shall allow identity, token, and role related data to be imported into the system directory structure:
- a. Importing of information shall occur in the following method:
 - 1) Add/modify: If a record in the file exists in the directory structure, it shall be replaced according to the layout configuration specified.
 - 2) Records that do not already exist shall be added to the directory structure.
 - b. Identity pull collaborations shall support BLOB image file formats to be imported into the open LDAP directory structure.
 - c. The ability to encrypt the exported identity information shall be available using SSL encryption.
 - d. Each collaboration shall utilize an error log that shall report all errors that occur during a file import. All errors can then be viewed from this log and once corrected the import may be run a second time to download the corrected records.
 - e. As a collaboration pull completes, imported changes shall be automatically downloaded to intelligent controllers on a real-time basis as information is being imported into the directory structure.
6. Event push collaborations shall allow alarm and events to be exported from the ACS to other 3rd party reporting engines.
- a. Each event push collaboration shall be defined with specific event types to be exported along with the schedule in which they are to be exported.
 - b. Events shall have the option to be exported with detailed alarm response information including acknowledgments, clears, and operator notes.
7. Collaborations shall allow administrators to select a subset of data for export or import operations. Filters shall be used to define which records would be selected for the import or export.

2.05 ACCESS CONTROL FIELD EQUIPMENT

- A. The access control panels shall include integrated power supplies, intelligent controller, two door modules (up to 8 modules) and input/output modules as required.
- 1. Intelligent controller:
 - a. The intelligent controller shall provide decision making, event reporting, and database storage for hardware platform. Two reader interfaces shall provide control for two doors and capable of supporting up to an additional 62 doors in paired and or alternate reader configurations with peripheral interface devices.

- b. The controller shall communicate with the host via on-board 10BaseT/100BaseTX Ethernet port.
- c. Two physical barriers shall be controlled. Each reader port shall accommodate a read head that utilizes Wiegand, magnetic stripe, or 2-wire RS-485 electrical signaling standards, one or two wire LED controls, and buzzer control.
- d. Technical specifications:
 - 1) Primary power: 12 to 24 volts DC, +/- 10-percent, 500mA maximum.
 - 2) Communications ports:
 - a) Host port 0: 10/100 Ethernet.
 - b) Host port 1: RS-232.
 - c) Peripheral interface port: RS-485, 2-wire.
 - 3) Inputs:
 - a) Eight (8) general purpose, programmable circuit type.
 - b) Two (2) dedicated: Tamper and power monitor.
 - 4) Outputs: Four (4) relays, Form-C, 5 amp, 30volt DC.
 - 5) Readers ports, two (2) reader ports:
 - a) Unregulated pass-through (150mA maximum) or regulated 12 volt DC.
 - b) Signaling clock/data, Wiegand or 2-wire RS-485.
 - 6) Keypad: Multiplexed with card data.
 - 7) LED: Two-wire or one-wire bicolor support.
 - 8) Buzzer: One-wire LED mode.
 - 9) Temperature: 0 to 70 degrees C operational, -55 to 85 degrees C storage.
 - 10) Humidity: 10 to 95-percent relative humidity, non-condensing (RHNC).
 - 11) Standards:
 - a) UL294 recognized, CE compliant, RoHS.
 - b) FCC Part 15 Class A, NIST certified encryption
 - 12) Technical features for connectivity: 10/100 Ethernet, RS-232, Dial-up.
- e. Door control:
 - 1) Two-reader ports: Clock/data, Wiegand, or RS-485.
 - 2) Eight (8) programmable inputs, four (4) relays, diagnostic LEDs.
- f. Access control:

- 1) 240,000 cardholder capacity, 50,000 transaction buffer, 32 access levels per cardholder, 19-digit (64-bit) user ID and 15-digit PIN numbers maximum. Activation and deactivation dates, if/then macro capability.
- g. Card formats:
 - 1) Eight (8) active card formats per intelligent controller.
 - 2) 19-digit (64-bit) user ID and 15-digit PIN numbers maximum.
 - 3) PIV-II, CAC, TWIC card compatible.
- h. Card reader functions:
 - 1) Multiple card format support by reader.
 - 2) Paired reader support.
 - 3) Alternate reader support.
 - 4) Elevator support.
 - 5) Turnstile support.
 - 6) Biometric device support.
 - 7) Open supervised device protocol (OSDP) compliant.
 - 8) Occupancy count.
 - 9) Support of multi-occupancy rules.
 - 10) Anti-passback support.
 - 11) Area-based, reader-based, or time-based.
 - 12) Nested area, hard, soft, or timed forgiveness.
 - 13) Supports host-based approval rules.
 - 14) Keypad support with programmable user commands, card input.
 - 15) Shunt relay support.
 - 16) Strike follower relay support.
- i. Database functions:
 - 1) Configurable card database.
 - 2) Supports up to nineteen (19) digital card numbers.
 - 3) Supports pin codes up to fifteen (15) digits.
 - 4) Programmable card activation and deactivation times and dates.
 - 5) Card issue code, ADA and VIP flags (up to 32-bits); PIV (75-bits); smart card (200-bits).
 - 6) Up to 128 access levels per user.
 - 7) Ability to track people and objects.
- j. Intrusion alarm functions:
 - 1) Supports entry delays and exit delays.

- 2) Area monitoring.
 - 3) Standard alarm masking.
 - 4) Provides control and alarm processing from the keypad.
2. Two door controllers:
- a. The peripheral interface device shall provide a solution for interfacing to TTL/Wiegand/RS-485 type readers and door hardware. The intelligent controller shall accept data from a reader with clock/data, Wiegand or RS-485 signaling, provide a tri-stated LED control and buzzer control. It shall also provide six (6) Form-C relay outputs and eight (8) supervised inputs for monitoring. The controller shall communicate via a 2-wire, RS-485 interface.
 - b. Technical specifications:
 - 1) Primary power:
 - a) 12 to 24 volt DC. +/- 10-percent, 500mA maximum.
 - b) 12 volt DC @ 450mA nominal, plus reader current.
 - c) 24 volt DC @ 270mA nominal, plus reader current.
 - 2) Communications ports:
 - a) Peripheral interface port: RS-485, 2-wire.
 - b) Reader interface: Two (2) reader ports, data card/keypad, clock/data, data-1/data-0, or 2-wire RS-485.
 - 3) LED: One-wire bi-color LED support or two-wire.
 - 4) Buzzer: One-wire LED mode.
 - 5) Keypad: 8-bit Mercury, 8-bit Dorado, or 4-bit HID
 - 6) Reader Power: Pass-through or 12 volt DC regulated power, 125mA each reader.
 - 7) Inputs: Eight (8) general purpose programmable type and two dedicated for tamper and power monitor.
 - 8) Outputs: Six (6) relays, Form-C, 5 amp at 28 volt DC.
 - 9) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.
 - 10) Humidity: 10 to 95-percent RHNC
 - 11) Standards: UL 294 recognized, CE compliant, RoHS
 - c. Technical features:
 - 1) Card formats:
 - a) Eight (8) active card formats per intelligent controller.
 - b) 19-digit (64-bit) user ID and 15-digit PIN numbers maximum.
 - c) PIV-II, CAC, TWIC card compatible.
 - 2) Card reader functions:

- a) Multiple card format support by reader.
- b) Paired reader support.
- c) Alternate reader support.
- d) Turnstile support.
- e) Biometric device support.
- f) Keypad support with programmable user commands, card input.
- g) Shunt relay support.
- h) Strike follower relay support.
- 3) Database functions: Supports up to nineteen (19) digital card numbers.
- 4) Intrusion alarm functions:
 - a) Supports entry delays and exit delays.
 - b) Provides control and alarm processing from the keypad.
 - c) Offline mode operation.
 - d) Door mode: Unlocked, locked, facility code only.
 - e) Relay mode: Programmable for offline conditions.
- 3. In/out modules:
 - a. Input and output modules shall be used for the connection of peripheral sensors and electric locks at the door if required when devices are greater than the door controllers can support.
 - b. Input modules:
 - 1) The peripheral interface device shall be used to monitor sixteen (16) inputs.
 - 2) Primary power:
 - a) 12 to 24 volt DC, ± 10 -percent, 350mA maximum.
 - b) 12 volt DC at 300mA nominal.
 - c) 24 volt DC at 220mA nominal.
 - 3) Communication: 2-wire RS-485, 4,000-feet using Belden #9841.
 - 4) Inputs: Sixteen (16) general purpose programmable type and two (2) dedicated for tamper and power monitor.
 - 5) Outputs: Two (2) relays, Form-C, 5amp, 28 volt DC.
 - 6) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.
 - 7) Humidity: 10 to 95-percent RHNC.
 - 8) Standards: UL 294 recognized, CE compliant, RoHS.
 - 9) Offline mode operation.
 - 10) Relay mode.

11) Programmable for offline conditions.

c. Output modules:

1) The peripheral interface device shall be used to provide sixteen (16) dry contact outputs to auxiliary equipment such as locks or to activate alarm.

2) Primary power:

a) 12 to 24 volt DC, ± 10 -percent, 1100mA maximum.

b) 12 volt DC at 850mA nominal.

c) 24 volt DC at 450mA nominal.

3) Communication: 2-wire RS-485, 4,000-feet using Belden #9841.

4) Inputs: Two (2) dedicated for tamper and power monitor.

5) Outputs: Sixteen (16) relays, Form-C, 5amp at 28 volt DC.

6) Temperature: 0 to 70-degrees C operational, -55 to 85-degrees C storage.

7) Humidity: 10 to 95-percent RHNC.

8) Standards: UL 294 recognized, CE compliant, RoHS

9) Offline mode operation.

10) Relay mode.

11) Programmable for offline conditions.

B. Proximity card readers:

1. Provide one reader at each new card reader access control door opening noted on the Drawings.

2. Card reader specifications:

a. Frequency: 125kHz contactless smart cards supported.

b. 13.56 MHz contactless smart cards supported. iClass Seos, iClass SE, iClass, MIFARE Classic, MIFARE DESFire EV1

c. Protocol: Open supervised device protocol (OSDP) mode, Wiegand, clock/data modes.

d. Voltage: 5 to 16 volt DC.

e. Power supply: Linear DC.

f. Cable Distance: 500-feet.

g. Color: Black

h. Mount readers on shallow depth single gang, double-gang electrical boxes as required or mullion mount.

i. Provide read tamper switch.

C. Door monitor switch:

1. Provide low-voltage magnetic door position sensor, as follows:

- a. Mounting: Recessed.
 - b. Switch type: Single pole, double throw switch.
 - c. Gap distance: 0.5" maximum.
 - d. Installation: For wood, steel, and hollow metal doors.
2. Roll-up doors:
- a. Mounting: Surface.
 - b. Switch type: Normally closed contacts.
 - c. Gap distance: 3.0" maximum.
 - d. Wiring: MC cable, 36" minimum.
- D. Access control cards:
- 1. Format: Weigand 35-bit.
 - 2. Frequency: 125kHz and 13.56mHz.
 - 3. Cards shall feature graphic-quality surface that supports direct-to-card printing.
 - 4. Capable of being produced with holograms, ultra-violet fluorescent inks, or other anti-counterfeiting features.
 - 5. Provide 1000 proximity cards.
- E. Request-to-exit (REX) motion sensors:
- 1. Power: 12 or 24 volt DC, 35mA.
 - 2. Relay output: Two (2) Form C, will be connected to the reader controller input. Includes adjustable relay latch time.
 - 3. Programmable retrigger or non-retrigger mode.
 - 4. Radio frequency interference (RFI): Immunity range from 26 to 1,000mHz at 50v/m.
 - 5. Color: Light gray or white color to match adjacent finishes.
 - 6. Mount device on ceiling or door frame. Exact location will depend on existing conditions and the required coverage area. Unless noted otherwise on Drawings, conceal wireways and junction box.
- F. Power Supplies and accessories:
- 1. Power supplies at panel assembly:
 - a. Provide power supplies with 12 and 24 volt DC outputs for all electrically controlled door locks. Power supplies shall permit simultaneous continuous-duty activation of all door locks, with an additional minimum 30-percent capacity on each supply. Provide battery back-up sufficient for 25 activations for all DC locks.
 - b. Power supply, as required by the system manufacturer.
 - c. Integrated battery charger.
 - 2. Power supplies at door controllers:

- a. Shall be able to house the access control door controller boards and in/out modules in a single panel.
- b. System requirements:
 - 1) 120 volt AC input.
 - 2) 12 and 24 volt DC outputs.
 - 3) On board fire alarm interface.
 - 4) Continuous and resettable DC.
 - 5) Distributed outputs, auxiliary and controlled.
 - 6) Network monitoring and reporting.
- 3. Batteries:
 - a. Batteries shall be UL Listed and suitable for the purpose of backing up power to ACS equipment, field devices, electric locks, etc.
 - b. System requirements:
 - 1) Voltage: 12 volt DC
 - 2) Amps: 12
 - 3) Chemistry: SLA or VRLA
 - 4) Termination: Spade protected terminals.
- 4. Accessories: If necessary, provide interfacing relays between access control panel (ACP) and electric locks being controlled.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the access control system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 COORDINATION

- A. Coordinate all installation requirements for door locks with other trades. Refer to door hardware.
- B. Install conduits, ceiling access panels, panel interface module, door hardware and connections to doors and frames for complete operating installation. All connections shall be concealed.

3.03 PROGRAMMING

- A. Special coordination is required with the owners facilities Office regarding programming requirements. Meet with owner representatives and submit proposed labels for all input and output points for review and comment. Software labels shall be consistent between various integrated systems.
- B. Program automatic door unlock, time specifications, and access levels as directed by the Owner.

3.04 INSTALLATION

- A. All electrical power work, conduit work, and power wire pulling shall be by licensed electricians, and all card reader installation and interconnection work shall be by the access control system certified technicians.
- B. Provide all wiring in conduit when exposed.
- C. Method and routing of any exposed raceways or wiring shall be approved by the owner prior to installation.
- D. Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.
- E. All cable shall be labeled at origin and termination, referencing to a master legend schedule shown on submittal drawings. Labeling and any splice locations shall be noted on Record Drawings.
- F. Provide 120 volt receptacle outlets dedicated to the access control panel power supplies.

3.05 WIRE AND CABLE PRODUCTS

- A. Security contractor shall follow the manufacturers' recommendation for cabling or the minimum requirements of the Specifications, whichever provides for the most stringent requirements.
- B. Cables are to be shielded as necessary to preclude any outside noise or interference from entering the cable and degrading system performance. All cables shall be UL Listed, and appropriate for the application.
- C. Coordinate with the owner's IT department connections to onsite monitoring.
- D. Cables run underground, under slab, or in slab shall be installed in conduit and rated for direct-burial application. Cables exposed to weather shall be rated for that use.
- E. Mixing of low-voltage cables with telephone/data cables is not permitted.
- F. All cables shall be run in unbroken lengths of 1,000-feet or less. When cable cannot be run in unbroken lengths due to cable spool limitations.
- G. The use of all screw type connectors i.e., snap caps, wire nuts, and the "twist and tape" method are prohibited.
- H. All 24 volt AC power cabling shall be of stranded construction. Terminal strips and fork spade lugs shall be utilized for all terminations.
- I. Wiring shall be grouped, bundled, harnessed, and dressed neatly to facilitate access to all equipment, as well as maintenance and replacement of equipment.
- J. All cable shall be labeled at origin and termination, referencing to a master legend schedule as shown on "As-Built" Record Drawings. Labeling and any splice locations shall be noted on "As-Built" Record Drawings. All labels shall be done using machine generated cable tags in the "flagged" position. Handwritten labels are not acceptable.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the access control system.
- B. Pretesting objectives shall be to:
1. Assure system installation conforms to specified requirements and operates within specified tolerances.
 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 4. Apply label on security system control panel upon satisfactory completion of tests and results.
 5. Verify settings and make final adjustments.
- C. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- D. Pre-functional testing:
1. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 2. Electrical tests:
 - a. The system shall be completely tested prior to final acceptance testing. All points shall be tested from point of initiation to the final point or points of annunciation. All circuits shall be tested for continuity and ability to transmit the required signal correctly to the controller. Any problem due to wrong wire type, wire twist, impedance, mismatches, noise filtering or shielding shall be completely corrected during pretesting and prior to any final acceptance tests.
 - b. Testing shall include each device in the system. Coordinate with other trades as necessary for testing.
 - 1) Door controllers: Verify controller is powered and connected to the network.
 - 2) Card reader: Ensure that card reader provides feedback from illuminated LED display, green if successful, red if not successful, with audible beep.
 - 3) Request to exit: Ensure that request to exit devices disengage electric locks and re-engage the locked position after door returns to closed position.

c. Test report:

- 1) Provide a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
 - 2) Submit two typed copies of the test report in a neatly bound folder for review and approval. Failure to comply with this will result in a delay of final testing and acceptance.
- E. In the event that the system fails to function properly during the testing, as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.
- F. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- G. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.07 TRAINING

- A. Factory authorized service representative shall conduct an 8-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 281300

SECTION 281600**SECURITY INTRUSION DETECTION SYSTEM****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
1. Intrusion detection system.
 2. Main control/communicator panels.
 3. Digital keypad arming/disarming stations.
 4. Motion detectors.
 5. Glass break detectors.
 6. Door position contact switches.
 7. Request to exit.
 8. Duress buttons.
 9. Accessories.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
1. Division 08: Door Hardware.
 2. Division 26: Line-voltage power service to equipment.
 3. Division 27: Telephone line service and network connection interface.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

1. Underwriters Laboratories, Inc. (UL):

UL 13;	Power-Limited Circuit Cables.
UL 294;	Access Control System Units.
UL 603;	Power Supplies for Use with Burglar-Alarm Systems.
UL 639;	Intrusion-Detection Units.
UL 681; Systems.	Installation and Clarification of Burglar and Hold Up Alarm
UL 1076:	Proprietary Burglar Alarm Units and Systems.

2. Electronics Industries Alliance (EIA):
EIA: Testing standards.

1.03 SYSTEM DESCRIPTION

A. System overview:

1. The Digital Intrusion Detection System (DIDS) is a network of distribution control panels and monitoring devices covering multiple areas that can be armed and disarmed independently of each other or in alarm zones.
2. The DIDS is an independent system and can be integrated with the Security Access Control System, for monitoring the building perimeter and designated interior spaces for generating alarms.
3. The DIDS shall consist of control panel, communicators, zone expanders, keypads, output modules, battery backup, and sensor devices. The control panel shall communication with the Security Access Control System via the Owner's LAN and/or hardwired connections.
4. Activation of the DIDS shall notify the 3rd party monitoring agency (TBD) as the primary responder with security staff as secondary responders.

B. Intrusion detection system:

1. Provide the DIDS control panel with an integrated digital communicator containing connections for the LAN and to a dedicated outside telephone line for remote monitoring by contracted central monitoring location and/or a 3rd party monitoring company.
2. Provide 16.5 volt AC power supplies for DIDS to power the control panel and keypads.
3. Provide secondary 12 volt DC power supply module for motion detectors and other accessories.
4. Provide battery charger and battery backup for each power supply to keep the DIDS operational for 8-hours in the event of an AC system power failure. Include output connection from the DIDS to the Security Access Control System as an alarm trigger for AC power failure and low battery condition. Program unsupervised inputs for this purpose.
5. Provide expansion input modules to the DIDS panels as necessary to support the field devices shown on the Drawings.
6. The DIDS shall accommodate hard-wired or wireless point expansion via expansion point interface modules and RF receivers.
7. Keypads shall be installed at locations shown on drawings to provide individual zone control of a building. Keypads shall allow access to programmed zones via a 1 to 5-digit access code. They shall be capable of "disarming" or "arming" functions. A delay feature shall be built into the system to provide personnel sufficient time to disarm system upon entering a building prior to activation of an alarm sequence.
8. Program duress alarm input buttons as 24-hour zones.
9. Provide magnetic contact switches on perimeter doors to monitor door position and detection of forced entry. Provide double-pole double-throw contacts on doors with local audible alarms. Provide connection between one contact to audible alarm and the other contact to the DIDS.

10. Both motion detectors and door position contact switches shall transmit an alarm condition when the buildings are "armed" and system is violated.
11. Glass break detectors shall be installed at all exterior glass in all interior spaces indicated on the Drawings.
12. Interface with Security Access Control System (ACS):
 - a. Connect designated ACS alarm inputs to the DIDS control panel. Provide expansion input modules to the DIDS panels as necessary to support output from the ACS.
 - b. Connect designated ACS alarm outputs to the DIDS control panel inputs. Provide expansion input modules to the DIDS panels as necessary to support input from the ACS.
 - c. Provide software interface with the ACS.
13. Interface with the Security Video Management System (VMS): Provide software interface to the VMS platform. Program the DIDS software and the VMS software, as needed, such that alarm events make the video associated with that alarm device call up onto the main monitor and to mark the video recording.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment and dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 4. Shop Drawings:
 - a. Plot plans and building floor plans, showing location of and conduit routing to all devices.
 - b. Point-to-point wiring diagram in block or riser formats showing all components, conduit and wire types and sizes with cable legend.
 - c. Include elevations of control panel and remote terminal cabinet(s).
 5. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety & Security Requirements.
 6. Submit Manufacturer's installation instructions.
 7. Complete bill of materials listing all components.
 8. Warranty.

1.05 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, to include the following:

1. A detailed explanation of the operation of the system.
2. Instructions for routine maintenance.
3. Pictorial parts list and part numbers.
4. Schematic Drawings of wiring system, including all devices, control panel, terminal cabinets, etc.
5. Telephone numbers for the authorized parts and service distributors.
6. Final testing reports.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Security intrusion detection system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. Units and components offered under this Section shall be covered by a **1**-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Control panel:
 - a. Bosch Security Systems, #D9412GV4.
 - b. Honeywell.

- c. Kantech.
- d. Mercury.
- e. Allegion.
- f. Avigilon.
- 2. Communicator:
 - a. Telular, TelGuard.
- 3. Keypad:
 - a. Bosch Security Systems, #D1260.
- 4. Motion detector:
 - a. Bosch Security Systems.
 - b. Optex.
 - c. Honeywell.
- 5. Glass break detector:
 - a. Bosch Security Systems
- 6. Door position contact switch:
 - a. Doors:
 - 1) Honeywell #947-45.
 - 2) Magnasphere #HSS-L2C.
 - 3) SECO #SM-4105.
- 4) Sentrol #1076D.
 - b. Roll-up Doors:
 - 1) Magnasphere #MSS-105S.
 - 2) SECO #SM-226R.
 - 3) Sentrol #1949-L, floor mount.
 - 4) Sentrol #1912-L, aluminum L-bracket.
- 7. Request to exit modules:
 - a. Bosch #DS160 with TP160 trim.
 - b. Honeywell #IS320WH with IS310WHTP trim.
- 8. Duress button:
- 9. Power supplies and battery charger:
 - a. LifeSafety Power MCLASS, Dual Voltage series.
- 10. Batteries:
 - a. Interstate Batteries #SLA1105 sealed lead acid series.
 - b. Yuasa Battery Inc. #RE12-12 sealed lead acid series.

- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety & Security Requirements.

2.02 MAIN CONTROLLER/COMMUNICATOR PANEL

- A. Control Panel: Control Panel shall be surface mounted, NEMA 1 enclosure, having a key operated locking and hinged door. Opening the main door shall expose all components for inspection or adjustment without further dismantling of the cabinet, control units or wiring. Unit shall be complete with the following features:
1. Integrated telephone line interface with programmable options for signaling and supervision.
 2. Conettix IP based communication option provides high-speed, secure alarm transport and control.
 3. 32 programmable areas with perimeter and interior partitioning.
 4. 8 on-board, Class B hardwired points with expansion capability for a total of 246 wired or wireless points.
 5. Compatibility with touch-screen color LCD, vacuum fluorescent, ATM style LCD or LED style alarm command centers.
 6. Local or remote programming, test, and diagnostic capability via a computer running the remote programming software (RPS).
 7. The system shall support the use of an Apple iOS device for control. Functions to include arming, disarming, control of outputs, lock, unlock, cycle and secure access doors.
 8. Integrated real time clock, calendar, test timer and programmable scheduling capability for relay control and automatic execution of system functions based on a time/event.
 9. Provide 1.4 amps of power for standby operation and 2 amps of alarm power, both rated at 12 volt DC.
 10. 2 wet-contact relay outputs and 1 auxiliary wet-contact relay output with expansion capability for up to an additional 128 dry-contact relay outputs.
 11. Integrated battery charger with reverse hook up protection, battery supervision and battery deep discharge protection.
 12. Supervision of peripheral devices and communications interface(s).
- B. Point functionality and expansion:
1. Each point in the system shall be programmable to provide the following type of response in the system:
 - a. Always on (24-hour response).
 - b. On when the system is master armed.
 - c. Only on when the system is perimeter armed.
 - d. Displays/does not display when the point is activated.
 - e. Provides/does not provide entry warning tone.

- f. Sounds/does not sound audible alarm indication.
 - g. The point is bypass-able/not bypass-able.
 - h. Alarm verification with programmable verification time.
 - i. Relay activation by point.
 - j. Provides/does not provide "watch point" capability.
 - k. Provides swinger bypass.
 - l. Defers bypass report.
 - m. Can return to the system after being force armed and then restoring.
 - n. Can return to the system after being bypassed and then restoring.
- 2. The DIDS shall be capable of supporting "group zoning." Group zoning refers to the combining of points into a separately identifiable and separately annunciated (programmable text) areas.
 - 3. The DIDS shall be capable of allowing variable point response times via programming. Point response times shall be programmable over a range of 300-milliseconds to 4.5-seconds.
 - 4. The DIDS shall have the capability to expand up to 246 separately identifiable points, of which 8 are on-board and 238 are off-board wired or wireless addressable points connected to multiplexed backbone trunks via wired modules and/or wireless receivers.
 - a. The 8 on-board points shall be able to accommodate powered Class B functionality using a powered loop interface module.
 - b. Point expansion modules (wired and wireless) shall be able to be located remote to the main panel to a maximum distance of 1000-feet.
- C. Areas/accounts:
- 1. The DIDS shall support 32 independent areas. Each of the 32 areas shall have custom text associated with the armed state, disarmed state, and point off normal state.
 - 2. The DIDS shall be capable of assigning 1 to 32 account identifiers to the areas depending on the distribution of areas per account.
 - 3. The DIDS shall be capable of linking multiple areas to a shared area which may be automatically controlled (hallway or lobby).
 - 4. The DIDS shall accommodate conditional area arming dependent on the state of other areas (master or associate). Any area can be configured for perimeter and interior arming, not requiring a separate area for this function.
- D. Output relay expansion: The DIDS shall provide the capability for output relay expansion using relay expansion modules. Independent control of relay functions by area shall be possible through programming assignments. The DIDS shall be capable of activating 128 additional relay outputs for auxiliary functions based on its classifications (area verse panel wide). Output expansion modules shall be able to be located remote to the main panel to a maximum distance of 1000-feet. 8 relays (Form C) are to be provided per octo-relay module

- E. Scheduling: The DIDS shall support scheduling capabilities with the following characteristics:
1. Arm/disarm specific area(s) based on open/close windows.
 2. Bypass/un-bypass point(s).
 3. Activate/deactivate relay(s).
 4. Send test reports.
 5. Up to 4 programmable holiday schedules of 366 days each (includes leap year). Based on the holiday settings, different time windows for open/close and other system functions can be executed.
 6. Automatic adjustment of system clock for daylight savings time.
 7. Turn an access authority level on/off.
 8. Hold a door open (unlocked and shunted).
 9. Secure a door closed (locked, no valid cards will allow entry).
 10. Return a door to normal operation (locked, valid cards will allow entry).
 11. Turn recording of access granted events on/off (and transmittal if routing is on).
 12. Turn recording of access denied events on/off (and transmittal if routing is on).
- F. Alarm command centers (ACC):
1. The DIDS shall accommodate connection with up to 32 ACCs, each capable of displaying custom English text on touch screen liquid crystal or vacuum fluorescent (VF) displays.
 2. The ACCs shall accommodate viewing and configuration of system parameters including:
 - a. Network Parameters:
 - 1) DHCP enable/disable for the selected network module.
 - 2) UPnP enable/disable for the selected network module.
 - 3) IP address for the selected network module.
 - 4) Subnet mask for the selected network module.
 - 5) Default gateway for the selected network module.
 - 6) Port number for the selected network module. The module's port number shall range from 0 to 65,535.
 - 7) DNS server address for the selected module's DNS server IP address
 - 8) DNS host name for the selected module. The DNS host name shall contain up to 63 characters.
 - 9) AES encryption key size: Enable/disable encryption by selecting the AES encryption key size for the selected network module.

- 10) AES encryption key string: The user shall be able to display, add and modify the AES encryption string based upon the key size previously configured for the selected network module.
- b. Point parameters:
 - 1) Point selection between one and the maximum number of points in the control panel.
 - 2) Point registration to allow system response from a specific physical point on any one of the expansion modules, on-board, point expansion modules (wired or wireless), and access.
 - 3) Wireless points shall be able to be enrolled in the system via an auto learn feature.
- c. Event routing parameters to allow programming of up to 4 report routing groups as well as configuration of primary and secondary paths.
- G. User passcodes and authority. The passcodes shall be programmable with authority levels to allow users to operate any or all areas:
 1. Up to 999 different passcodes shall be accommodated.
 2. Each passcode shall be 3 to 6 digits (variable) and be assigned a 16-character username that shall be printed on the local printer and receiver with associated opening and closing reports from the user.
 3. User access to system features and functions shall be configurable based on 14 individually programmable levels of authority assigned to the user passcode. Additionally, the system shall have the capability to assign to the user passcode, a different authority level in each of the areas. A service passcode can be assigned to the servicing agent allowing the agent limited access to system functions. User-programmable/activated functions include:
 - a. Arming the system: All areas, specific area(s) only, perimeter instant, perimeter delayed, perimeter partial, watch mode, and arming the system with a duress passcode.
 - b. Disarming the system: All areas, specific area(s) only and disarming with a duress passcode.
 - c. Viewing system status: Faulted points, event memory, bypassed points, area status and point status.
 - d. Implementation functions: Bypass a point, un-bypass a point, reset sensors, silence bell, activating relays, initiating the remote programming function locally to allow programming the system from a remote location.
 - e. Testing the system: Local walk test, service walk test, send report to remote receiver to check the telephone link, and programming the time and date for the next test report transmission.
 - f. Change system parameters: ACC display brightness, system time and date, and add/delete/change passcodes.
 - g. Extend the closing time of the system.
 - h. Transmitting special alerts and activating audible and visible signals.

- i. Executing multiple commands/ACC keystrokes from a single menu/command list item. This function shall be able to have a 16-character (alphanumeric) title to identify it on the ACC display.
 - j. Editing of time/event-based scheduling program from the ACC.
- 4. The DIDS shall also provide a "service menu" to implement functions such as viewing and printing the system log, displaying the system firmware revision number, and defaulting (toggling) text displays between custom and default text displays for troubleshooting.
- 5. The DIDS shall allow users to change their own user passcode from the ACC. Managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
- 6. The DIDS shall incorporate a programmable "passcode follows scope" feature to allow users to arm or disarm only the area they are entering with one simple command or control all areas from one ACC.
- 7. Passcodes shall be able to be associated with a unique access card/token. The authority of the card assigned to the user will equal that of the user, and each card will report in the display, local printer, memory event log and at the receiver as a unique, individual, user.
- H. Communication: The DIDS shall be capable of reporting system events and supervisory reports including alarm, trouble, missing modules, restorals, system status, AC failure, battery status to primary and secondary off-site receivers. The following features shall be supported:
 - 1. The DIDS shall be capable of communicating via dial-up analog telephone lines, over a LAN/WAN/Internet using a wired network interface module, or over a cellular network using a GSM/GPRS interface module.
 - 2. The communications format shall be utilized for optimum system performance. The format provides the maximum data information to the receiver for alarms, troubles, restorals, bypasses, relay activation, opening/closings, etc. The detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information.
 - 3. The DIDS shall have the capability of communicating with up to 8 different receivers using up to 4 different phone numbers, up to 24-digits in length and/or 4 URL/IP addresses over a network.
 - 4. The DIDS shall support 2 telephone lines using a dual phone line module. The lines shall be capable of being alternated for the transmission of consecutive events.
 - 5. The receivers shall provide the transmission information sent from the DIDS that includes alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. When using the format, the detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information.
 - 6. The DIDS reports shall be classified, by event, into eleven subcategories or "report groups." Each group represents similar types of events. Individual

events within each group shall be selectively enabled or disabled for transmission.
The eleven report groups shall be as follows:

- a. Fire reports.
 - b. Burglar reports.
 - c. User reports.
 - d. Test reports.
 - e. Diagnostic reports.
 - f. Relay reports.
 - g. Auto function reports.
 - h. RPS reports.
 - i. Point reports.
 - j. User change reports.
 - k. Access reports.
7. The DIDS shall be capable of listening to the telephone line when calls are answered by other devices on the premises side of the phone line and determining if a special tone is being sent from RPS and intercepting the call for RPS sessions.
 8. The DIDS shall have the capability to verify the integrity of the remote communications path and switch to alternate paths when a communications failure occurs.
 9. The DIDS shall be capable of unattended mode of operation whereby programming and configuration updates are automatically transferred using the RPS. These updates can initiate from either the control panel or the remote computer using RPS.
- I. Network communication: The DIDS shall be capable of network communications over a LAN, WAN, Intranet, or the Internet. The system shall include supervision of the network communication utilizing configurable periodic heartbeats to the receiver. The receiver shall provide notification of the loss of communications from a networked system after a programmable timeframe since the last communication. The notification options shall be programmable and include local annunciation or indication to automation software.
1. The network interface module shall be capable of supporting dynamic host communication protocol (DHCP) to obtain an IP address.
 2. The system shall support a method of authentication between the control panel and the receiver to ensure that the control panel has not been compromised or replaced.
 3. The network interface modules shall be capable of supporting encryption using a minimum of 128-bit AES Encryption (Rijndael) certified by NIST (National Institute of Standards and Technology).
 4. The network interface modules shall support a 10/100BaseT connection to an Ethernet network.

5. The control panel shall be capable of network communication with a programmable poll time to send periodic heartbeats to the receiver, programmable ACK Wait time, and programmable retry time. In the situation where a communication path is unsuccessful, the control panel shall be capable of attempting backup communication through an available communication method to the same receiver or a backup receiver.
 - a. The control panel shall have the ability to automatically adjust the heartbeat rate of a backup path that is using GPRS to the heartbeat rate of the primary path in case of a primary path failure. Upon restoral of the primary path, the heartbeat rate of the backup path shall automatically restore to the original rate. This allows a system utilizing GPRS communications to keep the wireless charges low.
 - b. The control panel shall be capable of two-way communication using a wired network interface module with a 10/100BaseT on a LAN/WAN/Internet configuration or with a wireless GPRS module on the internet.
 - c. The control panel shall be capable of configuring the destination of the receiver using a URL or static IP address.
 - d. The control panel shall be capable of using DNS to lookup the IP address of the receiver when programmed with a URL.
 - e. The control panel shall support UPnP for automated port forward configuration in the router where the control panel is installed.
 - f. The control panel shall support AutoIP to enable the RPS to connect to the control panel locally using an IP direct connection.
 - g. The control panel shall support configuration of the IP parameters from the keypad eliminating the need for a PC to configure the IP device.
 - h. The control panel shall support network diagnostics from a keypad to allow local testing of network connectivity. The diagnostics should include, Ethernet cable connected, gateway configuration ok, DNS lookup operational, and external network connectivity (such as the Internet) operational.
 - i. The system shall be capable of meeting DCID 6/9 and UL 2050 standards.
- J. Event Log: The DACS shall maintain a log of events indicating time, day, month, year, type of event, account number, area number, user ID, point text, user text and primary/secondary event route. The system shall allow the following characteristics:
 1. The DIDS shall be capable of storing up to 1000 events.
 2. The DIDS shall support the printing of these events on up to 3 local printers.
 3. The DIDS shall support viewing of logs locally at the ACC and remotely via an upload to a remote central station computer running the RPS.
 4. The DIDS shall provide notification via a report to the receiver when the event log reaches a programmable "percent full capacity." This allows retrieval of stored events via RPS to prevent any loss of event history.
 5. Group, signal type and area can route events to specific printers.

6. Each receiver shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destinations for the event. The transmission of grouped events allows the reporting of different types of information to different remote receivers.
- K. Testing, diagnostic, and programming facilities: The DIDS shall be capable of sending (manually or automatically) test and status reports to remote receivers.
1. The DIDS shall be capable of sending automatic tests daily, weekly, or once every 28 days. Automatic test times shall be programmable to provide an offset of up to 24-hours from the current time.
 2. Automatic test reports shall be programmable to be deferred by one test interval if any other report is transmitted in the current interval.
 3. Automatic test reports and remote system access for diagnostics shall be supported via a remote central station computer with RPS.
 4. The DIDS shall be programmable locally or remotely. Programming shall be accomplished via a command center or a computer with a RPS.
 5. The DIDS shall allow an on-site user to initiate remote programming while on-line with the servicing location. The remote programming device must provide a compare feature and allow for downloading either the stored program or the (un)modified program copied from the panel.
 6. The DIDS shall allow the local programming option to be disabled and must provide a method to program a panel while no one is on premises when the panel shares a line with an answering machine.
 7. The DIDS shall accommodate IP diagnostic to verify settings and operation of the network interface modules host name, MAC address, IPV4 address assignment. The IP connection test shall include link test to verify physical cable integrity, ping test to verify gateway response and to verify address on the internet.
 8. Wireless point diagnostics shall include signal strength and device states of registered wireless points in the system.
 9. The number of system testing and programming sessions shall be restricted via the use of program locking features and passwords. Passcode protection more than sixteen million combinations is required.
 10. New modules support enhanced diagnostics through RPS
- L. Miscellaneous features: Programmable alarm output timer, 31 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, key switch arming capability with LED outputs, and fire verification.
- M. False alarm reduction: The DIDS shall comply with all ANSI SIA CP-01 requirements for false alarm reduction
- N. Ambush detection: The DIDS shall include an early ambush feature that requires that the user disarm, and then inspect the facility within a specified time period, before entering their passcode or a different authorized passcode again. If the user does not enter a passcode a second time, a duress event is generated. If the user does enter a passcode within the specified time period, the system disarms.

- O. Two-man rule: The DIDS shall include a programmable feature that requires 2 separate passcodes to be entered to disarm the system. After 1 passcode is entered, the system will prompt for a second passcode to be entered on the same ACC. Without the second passcode, the system shall not disarm.
- P. User-programmable features: The DIDS shall provide a menu driven interface to provide a user-friendly command structure for programming/customizing the system to the operational criteria of the application. The DIDS shall be capable of being operated via:
 - 1. The command structure.
 - 2. Menu/command list.

2.03 SYSTEM INTERFACE REQUIREMENTS

- A. Grounding: The Contractor shall properly earth ground the DIDS to prevent electrostatic charges and other transient electrical surges from damaging the DIDS panel.
- B. Primary power: The Contractor shall provide a dedicated 120 volt AC power circuit to the DIDS system. This circuit shall be connected to the emergency power system, if available. The 120 volt AC is stepped down to power the DIDS panel using a Class 2, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.
- C. Primary power supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station.
 - 1. The message can also be programmed to "tag-along" with another message transmitted to the central station.
 - 2. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
 - 3. The transmission delay of this message is programmable from 5-seconds to 86-minutes with an optional 6 to 12-hour transmission delay.
- D. Secondary power (standby battery): The Contractor shall provide adequate battery power as defined by the relevant application criteria, (UL 864 and UL 985 for alarm installations or NFPA 72 chapters for fire applications). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.
- E. Secondary power supervision: When the secondary power source experiences an 85-percent depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.
- F. Telephone interface: The control panel in the DIDS shall be equipped with a phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection.
 - 1. The telephone line interface shall conform with FCC rules (Title 47 C.F.R. part 68).

2. When a telephone line is determined to be out of service by the DIDS panel, the event will be annunciated locally on the ACC and transmitted to the central station over the alternate communications interface. The transmission delay of this message is programmable from ten to two-hundred forty seconds.
 3. A telephone line switching module shall be used to interface to a second telephone line.
- G. Ethernet interface: The DIDS may use an Ethernet interface module as the primary, or back-up means of communicating to a receiver.
1. Built-in IP-based alarm transport, programming, and control.
 2. The module shall accommodate 128-bit AES encryption.
 3. 10BASE T or 100BASE T network connection.
 4. Full-duplex and half-duplex support.
- H. GSM/GPRS interface: The DIDS may use an GSM/GPRS radio module as the primary, or backup, means of communicating to a receiver. Up to 4 IP addresses shall be available for routing system events. The supervision time shall be programmable with a range of 5 to 65,535-seconds. This module shall accommodate 128-bit AES encryption.
- I. Auxiliary function control interfaces: The DIDS shall accommodate auxiliary functions such as activating bells, strobes, or lights and shall be accomplished using the optional application specific relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damage to the system.
- J. The contractor shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
1. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
 2. All signal cables provided under this contract shall be Class 2, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
 3. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
 4. Where EMI may interfere with the proper operation of the DIDS circuits, twisted, shielded cable shall be used.
- K. Environmental conditions: The DIDS shall be designed to meet the following environmental conditions:
1. The system shall be designed for a storage temperature of -10-degree C to 70-degree C (14-degree F to 158-degree F).
 2. The system shall be designed for an operating temperature of 0-degree C to 50-degree C (32-degree F to 120-degree F).
 3. The system shall be designed for normal operation in an 85-percent relative humidity environment.

4. The system shall meet or exceed the requirements of FCC rules Title 47 C.F.R. Part 15, Class B devices, and Part 68, IEC EMC directive.

2.04 DIGITAL KEYPAD

- A. Keypads shall come equipped with the following:
 1. LCD, 2-lines text (minimum), 16-character per line.
 2. Back lighted multi-key touch pad.
 3. Keys light on entry or key press.
 4. Audible annunciator (e.g., piezo buzzer) for audible feedback.
 5. User controlled/adjustable brightness and volume.
- B. Keypads shall provide the ability for each detection point the following:
 1. Alarm.
 2. Trouble.
 3. Supervisory.
 4. Faulted.
 5. Custom text.
- C. Keypads shall display system-wide events, including:
 1. Local system test.
 2. Sensor reset.
 3. Event log.

2.05 MOTION DETECTOR

- A. Dual technology, flush ceiling mounted, motion detectors, combining microwave technology with a dual element passive infrared technology. 360-degree field of view from 8 to 16-feet mounting height.
- B. Operating power: 40mA at 12 volt DC.
- C. Alarm relay: Energized Form C, 125mA at 25 volt DC.
- D. Trouble output relay: De-energized Form B, 125mA at 25 volt DC.
- E. Microwave frequencies: 24.125GHz.
- F. Operating temperature: -10 to 55-degree C and 5 to 95-percent relative humidity, non-condensing.
- G. Detection range: 50-foot diameter, 25-foot radius.

2.06 GLASS BREAK DETECTORS

- A. Glass break detectors shall be microprocessor-based sound analysis technology (SAT) to listen for the specific frequencies associated with breaking glass. Detector can be used to detect breakage of plate, tempered, laminated, and wired glass types.

- B. Audio signals are analyzed and must produce a specific frequency, signature, and timing relationship to cause an alarm condition. The sophistication of this processing technique ensures proper catch performance while eliminating false alarms.
- C. Mount detectors semi-flush on ceiling or walls.
- D. Standard coverage allows detectors to be located within 25-feet of window being covered.
- E. Power: 23mA at 12 volt DC.

2.07 DOOR POSITION CONTACT SWITCH

- A. Provide low-voltage magnetic door position sensor, as follows:
 - 1. Mounting: Recessed.
 - 2. Switch type: Single pole, double throw switch.
 - 3. Gap distance: 0.5" maximum.
 - 4. Installation: For wood, steel, and hollow metal doors.
- B. Roll-up doors:
 - 1. Mounting: Surface.
 - 2. Switch type: Normally closed contacts.
 - 3. Gap distance: 3.0" maximum.
 - 4. Wiring: MC cable, 36" minimum.

2.08 REQUEST-TO-EXIT (REX) MOTION SENSOR:

- A. Power: 12 or 24 volt DC, 35mA.
- B. Relay output: Two (2) Form C, will be connected to the reader controller input. Includes adjustable relay latch time.
- C. Programmable retrigger or non-retrigger mode.
- D. Radio frequency interference (RFI): Immunity range from 26 to 1,000mHz at 50v/m.
- E. Color: Light gray or white color to match adjacent finishes.
- F. Mount device on ceiling or door frame. Exact location will depend on existing conditions and the required coverage area. Unless noted otherwise on Drawings, conceal wireways and junction box.

2.09 ACCESSORIES

- A. Power supplies at panel assembly:
 - 1. Provide power supplies with 12 and 24 volt DC outputs for all electrically controlled door locks. Power supplies shall permit simultaneous continuous-duty activation of all door locks, with an additional minimum 30-percent capacity on each supply. Provide battery back-up sufficient for 25 activations for all DC locks.
 - 2. Power supply, as required by the system manufacturer.
 - 3. Integrated battery charger.

B. Power supplies at door controllers:

1. Shall be able to house the access control door controller boards and in/out modules in a single panel.
2. System requirements:
 - a. 120 volt AC input.
 - b. 12 and 24 volt DC outputs.
 - c. On board fire alarm interface.
 - d. Continuous and resettable DC.
 - e. Distributed outputs, auxiliary and controlled.
 - f. Network monitoring and reporting.

C. Batteries:

1. Batteries shall be UL Listed and suitable for the purpose of backing up power to ACS equipment, field devices, electric locks, etc.
2. System requirements:
 - a. Voltage: 12 volt DC
 - b. Amps: 12
 - c. Chemistry: SLA or VRLA
 - d. Termination: Spade protected terminals.

D. Terminal cabinets:

1. Provide a hinged door terminal cabinet in NEMA 1 enclosure. All conduits for security system shall terminate in these boxes. Provide engraved nameplate on each box marked "Security System Wiring".
2. Wireways shall be provided around the intrusion, access control and power supply enclosures for routing cable and terminating conduit.
3. Size terminal cabinets and wireway enclosures as required.

E. Accessories: If necessary, provide interfacing relays between access control panel (ACP) and electric locks being controlled.**PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Contractor shall thoroughly examine Project site conditions for acceptance of security intrusion detection system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 PREPARATION

- A. Ensure equipment locations are secure and protected from accidental damage.
- B. Location shall provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

- C. Ensure power sources are provided at locations required.

3.03 INSTALLATION REQUIREMENTS

- A. Install security intrusion detection system in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
- B. Install all equipment and materials in accordance with the following:
 - 1. Installation criteria defined in these Specifications and in the construction Drawings.
 - 2. Factory representative for system manufacturer.
 - 3. Approved submittals.
 - 4. Applicable requirements of referenced Codes and Standards.
- C. Alarm circuits shall be terminated on screw terminals. Terminal blocks shall be Allen-Bradley with 600 volt screw terminals for #22 to #10 conductors, mounted to type M22 channel or approved equal. Submittal shall show internal elevation of terminal cabinets with equipment laid out.
- D. All cables shall be run through fanning strip to terminals on terminal blocks.
- E. All cables entering terminal cabinet shall be identified with Brady or E-Z code wire markers. Upon completion of installation, six (6) copies of one-line "as-built" wiring diagram shall be furnished to the Owner.
- F. Each cable run on wiring diagram shall be identified with exact wire marker code (numerical or alphabetical) as appears in terminal cabinets.
- G. Station locations shall be identified by architectural room numbers and in all ways one-line wiring diagram shall relate as closely as possible to architectural Drawings.
- H. No splices shall occur in underground pull boxes. System wiring shall be continuous, without splices, from terminal cabinet to terminal cabinet and control panel to devices. All interior junction boxes shall be accessible, and locations shall be recorded on "As-Built" Drawings.
- I. Door contacts shall be located 6" from hinge side of door and both the switch and magnet shall be epoxy in place.
- J. After all equipment is installed and operational, Contractor shall set angle settings, sensitivity settings, etc., of each detector to ensure optimum performance and minimal false alarms. Mask out areas, of each detector, to remove sources of false alarms (windows, heaters, air diffusers, etc.), from detection zones.

3.04 WIRING

- A. Wiring from devices in building to terminal block at the same building shall be West Penn #241 or approved equal.
- B. Wiring from each building terminal block to the control panel shall be West Penn #244 or approved equal.
- C. Wiring from each keypad to the control panel shall be West Penn #244 or approved equal.

- D. Low voltage AC Power wiring shall not run close to or parallel to fluorescent lighting fixtures. If necessary, run conduit perpendicular to the lighting conduit with as much separation as possible.

3.05 PROGRAMMING

- A. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).
- B. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
- C. Programming passcodes according to the authorities and functions defined by the owner.
- D. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.
- E. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.
- F. Hard copy system printout: The contractor shall submit a hard copy system printout of all components tested and certify 100-percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
- G. Acceptance test plan form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.
- H. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

3.06 FIELD QUALITY CONTROL

- A. Contractor shall submit a written test report that the system has been 100-percent tested and approved. Final test shall be witnessed by the owner, engineer, electrical contractor, chief security officer, and performed by the installation contractor. Final test report shall be received and acknowledged by the owner prior to request for final payment.
- B. Provide instruction to the owner's satisfaction with regard to proper use and operation of the system.
- C. Determine and report all problems to the manufacturer's customer service department.

3.07 ADJUSTING

- A. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
- B. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

- C. The installer shall correct any system defect within six hours of receipt of call from the Owner.

3.08 DEMONSTRATION

- A. Demonstrate at final inspection that surveillance system and devices function properly.
- B. The Contractor upon completion of installation shall furnish training in the complete operation of the systems.

3.09 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before substantial completion.

3.10 TRAINING

- A. Factory authorized service representative shall conduct a 2-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 281600

SECTION 282300**SECURITY VIDEO SURVEILLANCE SYSTEM****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Video surveillance system.
 - 2. Video management system software.
 - 3. Network video recorder/server and storage.
 - 4. Network switch.
 - 5. Fixed dome IP network cameras.
 - 6. Panoramic dome IP network cameras.
- B. Related Work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 26: Electrical power service.
 - 2. Division 27: Communication horizontal cabling.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

- 1. Electronics Industries Alliance (EIA):

EIA: Testing standards.

- 2. Federal Communications Commission (FCC):

FCC Regulations: Part 15 – Radio Frequency Devices & Radiation Limits.

- 3. Underwriters Laboratories, Inc. (UL):

UL 13; Power-Limited Circuit Cables.

UL 497 Protectors for Paired-Conductor Communication Circuits.

UL 938; Surveillance Camera Units.

UL 2044; Commercial Closed-Circuit Television Equipment.

UL 3044; Surveillance Closed Circuit Television Equipment.

1.03 SYSTEM DESCRIPTION

- A. Provide a complete network-based video surveillance system as shown on the Drawings.

- B. Complete system is defined as cables, backboxes, IP color cameras, enclosures, digital network video recorder/servers, networking equipment, software, and programming needed to achieve a complete and functional system. Also, included are all required power supplies, power filtering, mounts, housings, and interfaces to equipment furnished by others.
- C. Program computer workstations to allow cameras to be manually displayed and automatically called up on alarm activation. Display maps (showing building, walls, level, and doors) reflecting the specific device and its status. Provide complete software integration of the PLC system functions and the graphic user interface (GUI) workstations.
- D. Provide complete integration with the access control system (ACS) to provide association of recorded video to ACS events and alarms.
- E. Provide automatic camera call-up upon activation of alarm detection, associated intercom activation, video motion detection, or input from other security or building systems as shown on Drawings.
- F. Security contractor shall include the following for rack mounted workstation:
 - 1. Network video recorder/server shall be compatible with Windows 7.
 - 2. Two (2) 23" LCD monitors.
 - 3. Keyboard.
 - 4. Optical mouse.
- G. Provide a network video software.
- H. Provide product requirements for a power-over-ethernet (PoE) network switch for network connection of surveillance cameras and the network server. Contractor will provide a Cisco PoE switch.
- I. Provide Category 6A data patch cords for interconnection of the surveillance components and cabling system.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop Drawings. A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

- a. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials.
 - b. Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
 - c. A riser diagram that individually depicts all headend equipment, servers, cameras, and power supplies, with cable interconnections.
 - d. Complete 1/8" = 1'-0 scale floor plan drawing locating all system devices and equipment. Floor plans shall indicate accurate locations for all control and peripheral devices as well as raceway size and routing, junction boxes, and conductor size, and quantity in each raceway.
 - e. Control panel wiring and interconnection schematics. The drawing(s) shall depict internal component placement and all internal and field termination points.
5. Submit Manufacturer's installation instructions.
 6. Complete bill of materials listing all components.
 7. California State Contractors License (C7 or C10 required).
 8. Warranty.
- B. Record Drawings:
1. Furnish Record Drawings as described in Section 280010: Basic Electronic Safety & Security Requirements, utilizing Shop Drawing submissions with updated field conditions. These Drawings shall include but not be limited to the following:
 - a. Plot plans and building floor plans, showing point-to-point wiring location of and conduit routing to all devices and cameras.
 - b. Block Diagram/Riser Diagram showing the system components and all conduit and wire type/sizes between equipment.
 2. Drawings shall be incorporated into the Record Drawing submission.
 3. Final acceptance will not be made until the Engineer has approved the Record Drawings.

1.05 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety & Security Requirements, to include the following:
1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic Drawings of wiring system, including all peripheral devices, host computers, monitors, control devices, etc.
 5. Telephone numbers for the authorized parts and service distributors.

6. Final testing reports.

1.06 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. All construction shall be performed by a California State Licensed Contractor. C7 or C10.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Surveillance system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.08 WARRANTY

- A. Units and components offered under this Section shall be covered by a 3-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.
- B. The warranty package shall include, but not be limited to the following:
 1. Emergency maintenance service.
 2. Service by factory trained service representative of system Manufacturer.
 3. Replacement of any defective components.
- C. Maintain regular service facilities and provide a qualified technician familiar with this Work at the Project site within four (4) hours of receipt of a notice of malfunction including weekends and holidays. Provide all material, devices equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by the Owner, complete and operational within twenty-four (24) hours after notification of a malfunction, at no additional cost.
- D. Conduct all warranty repairs and service at the Project site unless in violation of Manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to the Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts, and personnel to and from the Project site at no additional cost.

1.09 SYSTEM START-UP

- A. Upon completion of installation, a factory trained dealer service representative shall perform initial start-up of the surveillance system. Sufficient time shall be allowed to properly check the system out and perform required minor adjustments before the Engineer's witnessed test shall begin.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The following camera manufacturers products shall be REQUIRED:
1. VMS Software:
 - a. ExacqVision Technologies.
 - b. Genetec Security Center Omnicast.
 2. Network video recorder/server:
 - a. BCD Video.
 3. Network switch:
 - a. Dell PowerEdge #180AS KVM with Dell #XT912 LCD monitor, keyboard, and touchpad
 - b. Belkin #F1DC108H 19-inch sliding widescreen rack console
 4. Fixed dome IP interior network camera:
 - a. Axis #P3737-PLE Panoramic camera.
 5. Fixed dome IP exterior network camera:
 - a. Axis #P3737-PLE Panoramic camera.
 6. Panoramic dome IP interior/exterior network camera:
 - a. Axis #P3737-PLE Panoramic camera.
 7. Camera accessories:
 - a. Axis #T91B67 pole mount.
 - b. Axis #T91H61 wall mount

2.02 VIDEO MANAGEMENT SYSTEM (VMS) SOFTWARE

- A. The network video recorder shall come pre-loaded with VMS software.
- B. The VMS software shall provide the following features as a minimum:
1. System description:
 - a. One server connection per client.
 - b. Browser-based viewing of live and stored video.
 - c. Auto detection of supported cameras.
 - d. Support for fisheye and panoramic lens cameras.
 - e. Client bandwidth throttling.
 - f. Soft triggers.

- g. Pre- and post-alarm recording.
 - h. Continuous motion, time, or alarm-based recording, configurable per camera
 - 2. Power over Ethernet (PoE): Power cycle individual PoE ports.
 - 3. Live video view:
 - a. Multiple monitor view support.
 - b. PTZ control and presets.
 - c. Digital PTZ control and presets.
 - d. Motion and alarm indication.
 - e. Event linking on discrete inputs.
 - 4. Search, playback, export, archive:
 - a. Instant replay.
 - b. Event search:
 - 1) Thumbnail views.
 - 2) Timeline views.
 - c. Multi-camera playback.
 - d. Export options:
 - 1) DVD.
 - 2) .AVI or .EXE file.
- C. The video recorder/server shall have the ability to support upgraded VMS software providing additional advanced functionality, including the following:
 - 1. System:
 - a. Allow up to 512 via a thick client interface or 16 via web client.
 - b. Ability to specify minimum and maximum retention times on a per camera basis.
 - c. Time-lapse recording.
 - d. Extended storage.
 - e. Archiving.
 - f. Audit trail.
 - g. Custom user groups.
 - h. Intelligent search.
 - i. E-mail notifications on system health.
 - j. Enterprise level camera, server, and user management.
 - k. LDAP and active directory support.
 - 2. Live view:
 - a. Event linking on video, serial, and health events.

- b. Video wall support.
- c. Event-driven and time-based video switching.
- d. Camera groups.
- e. Multi-streaming.
- f. Event notifications.
- g. Map support, including hierarchical maps.
- h. Two-way audio.

3. Search, playback, export, archive for multiple camera export.

2.03 NETWORK VIDEO RECORDER (NVR):

A. The PoE NVR shall be an appliance to power and to acquire, record, store, and display video signals from 16 IP network video cameras or encoders.

B. The NVR appliance hardware shall have the following characteristics:

- 1. Camera/encoder connection:
 - a. 16 IP video cameras or encoders.
 - b. Power:
 - 1) PoE+ (per IEEE 802.3at).
 - 2) 25watts per port.
 - 3) 240watts total for 16 ports maximum.
- 2. Up to 12 TB of storage capacity.
- 3. H.264, MJPEG video compression.
- 4. Audio:
 - a. Microphone input: 1 RCA connector.
 - b. Outputs: 1 stereo (RCA connectors).
- 5. Server characteristics:
 - a. Operating system: Ubuntu Linux 14.04.
 - b. Processor: Intel Celeron.
 - c. RAM: 2 GB.
 - d. Monitor outputs: DVI-D, VGA.
 - e. USB 2.0 ports: 8 ports
 - f. Network interface: 1000 Base-T (Gigabit Ethernet).
- 6. Enclosure:
 - a. Material: Painted steel.
 - b. Dimensions: 10.9"L x 16.9"W x 3.5"H.
 - c. Weight: 14 lbs. maximum.

7. Electrical input voltage: 120 volt AC.
- C. The NVR shall support both thick client browser-based and a mobile web client interface:
 1. Thick client:
 - a. Client software shall be downloadable at no charge from the NVR Manufacturer's website and be fully compatible with all available features of the VMS server software.
 - b. The client software shall be available for Windows, Apple iOS, and Linux operating systems.
 2. Mobile web client:
 - a. A free mobile application shall be available permitting remote view of live and recorded video through the NVR.
 - b. The mobile application shall support PTZ control and the monitoring and activation of alarms and triggers for the mobile device.
 - c. The mobile application shall be available for devices running Apple iOS, Google Android, Microsoft Windows, and Amazon Kindle Fire software.
 - d. The mobile application shall allow simultaneous interaction with multiple NVR devices from the same Manufacturer.
 - e. The web service supporting the mobile application shall size the video stream to accommodate both low bandwidth and high bandwidth networks.
- D. Performance:
 1. The NVR shall be compatible with the specified cameras.
 2. The NVR shall have the further ability to connect to cameras prior to any initial camera settings and have initiate video recording without modification of the client settings.
 3. Video recording storage rate shall be 150 Mbps.
 4. Local client display rate shall be 270 frames per second.
- E. Environmental:
 1. Operating temperature: 40 to 95-degrees F.
 2. Power/heat load: 60watts/205 BTU per hour maximum.
- F. The NVR shall have optional expansion capability for alarm inputs and outputs.

2.04 NETWORK SWITCH

- A. The network switch provides users the ability to securely access and manage traditional servers remotely via their keyboard, video, and mouse ports, as well as the ability to manage these servers, and other devices like storage heads or network switches, regardless of whether the server or network is up and running. Devices are accessed via a modem connection or over a TCP/IP network. These connections support DES, 3DES, AES, or 128-bit SSL encryption of both KVM and Virtual Media sessions.

B. Switch description:

1. Device type: KVM switch, managed.
2. Features: 128-bit encryption, LDAP support, firmware upgradable, Virtual Media support, SSH support, Common Access (CAC) reader support, Smart Card reader support.
3. Ports: 8 x KVM
4. 17" LCD monitor, 1280 x 1024 resolution minimum.
5. Trackball or touchpad mouse.
6. Rack mounted chassis in a 1U sliding tray.
7. Dimensions: 17" x 9.2" x 1.7"
8. Power: 120 volt AC
9. Provide cables as required for connection to ACS and other rack mountable security devices.

2.05 FIXED DOME IP NETWORK CAMERAS**A. General:**

1. Camera:
 - a. Image sensor: Progressive scan RGB CMOS 1/2.5".
 - b. Lens:
 - 1) Varifocal: 3.5 to 10mm, F1.7.
 - 2) Horizontal field of view: 100 to 38-degrees.
 - 3) Vertical field of view: 51 to 22-degrees.
 - 4) Remote zoom and focus, P-iris control, IR corrected.
 - c. Day and night: Automatically removable infrared-cut filter.
 - d. Minimum illumination:
 - 1) Color: 0.18 lux at 50 IRE, F1.7.
 - 2) B/W: 0.04 lux F1.7 at 50 IRE, 0 lux with IR illumination on.
 - e. Shutter speed: 1/62500 s to 2 s.
 - f. Camera angle adjustment: Pan ± 180 -degrees, tilt -40 to +75-degrees, rotation ± 95 -degrees.
2. Video:
 - a. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, main and high profiles motion JPEG.
 - b. Resolution: 3072 x 1728 to 160 x 90.
 - c. Frame rate: 25/30 fps with power line frequency 50/60Hz.
 - d. Video streaming:
 - 1) Multiple, individually configurable streams in H.264 and motion JPEG.

- 2) Axis Zipstream technology in H.264.
- 3) Controllable frame rate and bandwidth.
- 4) VBR/ABR/MBR H-264.
- e. Multi-view streaming: 8 individually cropped out view areas.
- f. Pan/tilt/zoom: Digital PTZ, preset positions.
- g. Image settings: Compression, color, brightness, sharpness, contrast, local contrast, white balance, exposure control (including automatic gain control), exposure zones, fine tuning of behavior at different light levels, forensic WDR.
3. Network:
 - a. Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X (EAP-TLS) network access control, digest authentication, user access log, centralized management, brute force delay protection, signed firmware.
 - b. Supported protocols: Wide range of system protocols, 30-minimum.
4. Memory: 1GB RAM, 512MB flash.
5. Power: PoE IEEE 802.3a/802.3at Type 1 Class 3, maximum 11.5watt, typical 8.4watt.
6. Connectors: RJ45 10Base-T/100Base-TX PoE.
- B. Interior cameras:
 1. Casing:
 - a. IP52-rated, IK08 impact-resistant, polycarbonate casing with hard-coated dome and dehumidifying membrane.
 - b. Encapsulated electronics and captive screws.
 - c. Color shall be white, NCS S 1002-B.
 2. Mounting: Brackets with holes for junction boxes (double-gang, single-gang, and 4" octagonal) and for wall or ceiling mount.
 3. Operating conditions: -32 to 122-degrees F, humidity 10 to 85-percent RH (non-condensing).
 4. Dimensions: 4" high x 5-7/8" diameter.
 5. Weight: 1.2 lbs.
- C. Exterior cameras:
 1. Casing:
 - a. IP66-rated and NEMA 4X, IK10 impact-resistant, polycarbonate casing with hard-coated dome and dehumidifying membrane.
 - b. Encapsulated electronics and captive screws.
 - c. Color shall be white, NCS S 1002-B.

2. Mounting: Brackets with holes for junction boxes (double-gang, single-gang, and 4" octagonal) and for wall or ceiling mount.
3. Operating conditions: -40 to 122-degrees F. Start-up -22 to 122-degrees F. Maximum temperature of 131-degrees F. Humidity 10 to 100-percent RH (condensing).
4. Dimensions: 4-1/16" high x 5-7/8" diameter.
5. Weight: 1.7 lbs.

2.06 PANORAMIC DOME IP NETWORK CAMERAS

A. General:

1. Camera:

- a. Image sensor: 6 MP (3072 x 2048) 1/1.8" progressive scan RGB CMOS.
- b. Lens:
 - 1) Fixed iris, fixed focus, IR corrected, 1.6mm, F2.0.
 - 2) Horizontal field of view: 185-degrees.
 - 3) Vertical field of view: 185-degrees.
- c. Day and night: Automatically removable infrared-cut filter.
- d. Minimum illumination:
 - 1) Color: 0.16 lux at 50 IRE, F2.0.

2) B/W: 0.03 lux F1.7 at 50 IRE, F2.0

3) 0 lux with IR illumination on.

- e. Shutter speed: 1/100 000 s to 2 s.
- f. Camera angle adjustment: Rotation $n \pm 185$ -degrees.

2. Video:

- a. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, main and high profiles motion JPEG.

b. Resolution:

- 1) Overview: 2048 x 2048 to 160 x 160.
- 2) Panorama: 2560 x 960 to 192 x 72.
- 3) Double panorama: 2560 x 1920 to 256 x 144. 4) Quad view: 2560 x 1920 to 256 x 144.
- 5) View area 1-4:
 - a) 16:9: 1920 x 1080 to 256 x 144.
 - b) 4:3: 1920 x 1440 to 320 x 240.
- 6) Panorama corner left/right: 2368 x 1184 to 192 x 72.
- 7) Double panorama corner: 2048 x 2048 to 320 x 240.

8) Corridor: 2560 x 1920 to 256 x 144.

c. Frame rate:

- 1) 360-degrees overview, up to 2048 x 2048 without WDR, 50/60 fps at 50/60Hz.
- 2) 360-degree overview and dewarped views up to maximum resolution with WDR, 25/30 fps at 50/60Hz.

d. Video streaming:

- 1) Multiple, individually configurable streams in H.264 and motion JPEG.
- 2) Axis Zipstream technology in H.264.
- 3) Controllable frame rate and bandwidth.
- 4) VBR/ABR/MBR H-264.

e. Multi-view streaming: 360-degrees overview, dewarped panorama, double panorama, corridor and quad views. Up to 4 individually cropped out and dewarped view areas. All different views can be streamed simultaneously. When streaming 4 dewarped view areas and one 360-degree overview in maximum resolution, up to 14 fps per stream.

f. HDMI output: HDMI 1080p at 50/60 fps (50/60Hz).

g. Image settings: Compression, color, brightness, sharpness, contrast, local contrast, white balance, exposure control (including automatic gain control), exposure zones, fine tuning of behavior at different light levels, forensic WDR.

h. Pan/tilt/zoom: Digital PTZ of view areas, digital PT of panorama, corner, corridor and quad views, preset positions, guard tour.

3. Network:

- a. Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X (EAP-TLS) network access control, digest authentication, user access log, centralized management, brute force delay protection, signed firmware.
- b. Supported protocols: Wide range of system protocols, 30-minimum.

4. Memory: 2GB RAM, 512MB flash.

5. Power: PoE IEEE 802.3a/802.3at Type 1 Class 3, maximum 12.95watt, typical 7.7watt.

6. Connectors:

- a. Shielded RJ45 10Base-T/100Base-TX PoE.
- b. Terminal block for 1 supervised alarm input and 1 digital output (12 volt DC output, maximum load 25mA).
- c. HDMI type D.

B. Specific:

1. Casing:

- a. IP66-rated and NEMA 4X, IK10 impact-resistant casing in polycarbonate and aluminum, with hard-coated dome and dehumidifying membrane.
 - b. Encapsulated electronics and captive screws.
 - c. Color shall be white, NCS S 1002-B.
2. Operating conditions: -40 to 122-degrees F. Start-up -22 to 122-degrees F. Maximum temperature of 131-degrees F. Humidity 10 to 100-percent RH (condensing).
 3. Dimensions: 2-5/8" high x 5-7/8" diameter.
 4. Weight: 1.7 lbs.

2.07 CAMERA ACCESSORIES

A. Wall mount bracket:

1. Bracket is an aluminum wall mount with 1.5" NPS threads and white in color. Suitable for fixed dome pendant kits. The cable can be routed through the back hole or from the side by using a conduit connection.

2. Dimensions: 5-1/2" x 10-1/2" x 7-3/4"

3. Weight: 3.1 lbs.

B. Outdoor pendant kit:

1. For mounting camera on 1.5" NPS threaded brackets.
2. Pendant shall be white in color.

2.08 WIRE AND CABLE

A. Patch Cords:

1. For connection to each camera, network server ports and NVR.
2. Color: Green

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of the surveillance system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.
- B. Examine the surfaces, anchors and ground that are to receive materials, fixtures, assemblies, components, and equipment. Report the unsatisfactory conditions in writing to the Architect.

3.02 COORDINATION

- A. Coordinate and disconnect existing electronic/electrical equipment, services and/or controls to items being removed by others.
- B. Maintain a competent supervisor and supporting technical personnel, acceptable to the Engineer during the entire installation.

3.03 INSTALLATION

A. General:

1. The Contractor or subcontractor main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third party organization to confirm sufficient product and technology knowledge.
2. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
3. All firmware found in products shall be the latest up to date provided by the manufacturer, or of a version as specified by the provider of the Video Management System (VMS) software.
4. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords.
5. Install surveillance camera systems in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
6. Use methods and lubricating compounds on cables and wires to prevent damage to cables and wires during pulling. Provide compounds that are not injurious to the cable and wire jackets and do not harden or become adhesive.
7. Perform this Work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.
8. A complete, operating system shall be provided. Include all devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.
9. Provide wire, system devices, etc., shall be in accordance with applicable codes for systems as specified. Label all wiring and equipment.
10. The equipment and wiring shall be installed in a neat and workmanlike manner by trained surveillance camera installers.

B. Wire and Cable:

1. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Indicate the number designated on the associated field or Shop Drawings or run sheet, as applies. Assign wire or cable designations consistently throughout a given system, i.e., each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Additionally, provide labels where wire and cable first enter and exit from conduit, junction, or distribution boxes; labels shall be located within six (6) inches of the point of exit. Labels shall be by Brady or Thomas and Betts.
2. Secure all wire and cable run vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Cables shall be secured by screw-flange nylon cable ties or similar approved devices, Thomas and Betts or equivalent. Symmetrical clamping devices with split, circular or other wire conforming, nonmetallic bushings shall be provided for all other cables.

3. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.
4. Lace, tie or harness wire or cable as required herein and in accordance with accepted professional practice. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point.
5. Wiring for shielding certain conductors from others or routing in separate raceways, shall be as recommended by the Manufacturer's current requirements.
6. Label all cables at both ends of a run and within all pull and junction boxes using machine generated wrap-around labels.

C. Boxes:

1. Install all boxes square and plumb. Set "flush mounted" units so that the face of the cover, bezel or escutcheon shall be in the same plane as the surrounding finished surface. Mount boxes and trim so that there are no gaps, cracks or obvious lines between the trim and the adjacent finished surface and ready them to receive final finish, as applicable.
2. Install insulating terminations in signal circuit boxes, and wire ways of this Section.

D. Labeling:

1. Label each device in a concealed location with the system point number and address.

3.04 PROGRAMMING

- A. Prior to the completion of construction, the Contractor shall schedule a meeting with the Owner to determine all the programming criteria. The issues that shall be discussed is the CCTV camera call-up & recording features (including video motion detection).
- B. The Contractor shall document the results of the meeting and perform all necessary programming to achieve the Owner's requests.
- C. All programming shall be Windows 7 compatible.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the surveillance system.
- B. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration/adjustments and inspection required herein. Testing Agencies objectives shall be to:
 1. Assure Camera system installation conforms to specified requirements and operates within specified tolerances.
 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.

3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 4. Verify settings and make final adjustments.
 5. Perform a 100% pretest of the system prior to final Engineer testing. Provide the Engineer with the contractor testing and the independent testing results prior to final punch.
- C. At least five days prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- D. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.
- E. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.06 TRAINING

- A. Factory authorized service representative shall conduct a 4-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.
- B. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 282300

SECTION 283100**FIRE ALARM/LIFE SAFETY SYSTEM****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work included: Labor, materials, and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Fire alarm control panel(s) 'FACP'
 - 2. Fire alarm terminal cabinets 'FATC'
 - 3. Initiating devices
 - 4. Notification appliances
 - 5. Record Drawings
 - 6. Pretesting and final testing
- B. Work furnish and installed under another Section, but connected under this Section:
 - 1. 120volt AC power for equipment
 - 2. Telephone interconnection for remote dialing
- C. Related work: Consult all other Sections, determine the extent and character of related Work, and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 26: Electrical
 - 2. Division 27: Communication

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

- 1. American National Standards Institute, Inc. (ANSI):

ANSI C62.41; Guide for Surge Voltage in Low-Voltage AC Power Circuits

ANSI/ASME A17.1; Safety Code for Elevators and Escalators

- 2. National Fire Protection Association (NFPA):

NFPA 13; Standards for the Installation of Fire Sprinkler Systems

NFPA 72; National Fire Alarm Code

NFPA 90A; Standard for the Installation of Air Conditioning and
Ventilating Systems

NFPA 101; Life Safety Code

- 3. Underwriters Laboratories, Inc. (UL):

UL 38; Manually Activated Signaling Boxes

UL 268;	Smoke Detectors for Fire Protective Signaling Systems
UL 464;	Audible Signal Appliances
UL 497B; Circuits	Protectors for Data Communications and Fire Alarm
UL 864;	Control Units for Fire-Protective Signaling Systems
UL 1424;	Cables for Power-Limited Fire-Alarm Circuits
UL 1481;	Power Supplies for Fire-Protective Signaling Systems
UL 1638	Visual Signaling Appliances Standard
UL 1971	Signal Devices for the Hearing Impaired

4. Factory Mutual System (FM):

FM P7825	Approval Guide

1.03 DEFINITIONS

- A. Addressable device: A fire alarm system initiating, control or monitoring device module component on a signaling line circuit (SLC) with discrete digital identification that can have its status individually identified or that is used to individually control other functions, using site-specific programming at the fire alarm control panel.
- B. Alarm signal: A signal indicating an emergency that requires immediate action, such as a signal indicative of fire.
- C. Annunciator: A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.
- D. Circuits and pathways:
 - 1. Class B: Performance that does not include a redundant pathway and will not be capable of operation past a single open or ground fault condition but does include monitoring and annunciation of a trouble signal when either condition occurs. Any conditions that affect the intended operation of the path are annunciated as a trouble signal.
- E. Initiating device: A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box or supervisory switch.
- F. Initiating device circuit: A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.
- G. Notification appliances: A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs or any combination thereof.
- H. Notification appliance circuit: A circuit or path directly connected to a notification appliance(s).
- I. Signaling line circuit: A circuit or path between any combination of circuit interfaces, control units or transmitters over which multiple system input signals or output signals or both, are carried.

- J. Trouble signal: A signal initiated by the fire alarm system or device indicative of a fault in a monitoring circuit or component.

1.04 SYSTEM DESCRIPTION

- A. The fire alarm system shall be a microprocessor-based direct wired, multi-priority, peer-to-peer networked system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this Specification. It shall be complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer.
- B. It shall be 24Vdc closed circuit, electronically supervised, common signaling, device indicating, and automatic alarm type. The system shall include all wiring, raceways, pullboxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm and supervisory signal initiating devices, alarm notification appliances and all other accessories required for a complete operating system.
- C. Provide system with the following circuit and pathway performance:
1. Initiating devices circuits (IDCs): Class B.
 2. Signaling line circuits (SLCs): Class B.
 3. Notification appliance circuits (NACs): Class B.
 4. Additionally, all notification and communication circuits for partial evacuation systems (EVACS) shall comply with the survivability requirements of NFPA 72, Chapter 12, Level 2 and Level 3.
- D. Standby power: The standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for twenty 24-hours and capable of operating the system for 5-minutes of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery. The system shall automatically adjust the charging of the battery to compensate for temperature.
- E. Voltage drop:
1. Under all operating conditions, the voltage on the NAC must be sufficient to operate all the notification appliances so that they deliver the proper signal intensity. The worst-case operating condition shall be calculated from when the control unit primary power supply has failed and the battery capacity is at its lowest point. An end of useful battery life starting value of 20.4volts shall be used at the starting voltage unless the manufacturer's instructions indicate that a higher or lower value should be used. The current draw of an appliance at the minimum listed operating voltage (16volts) should be used.
 2. The point-to-point Ohm's Law voltage drop calculations of all alarm system circuits shall not exceed 10%.
- F. Spare capacity: The system shall be engineered to accommodate 20% spare capacity on each individual loop, and 20% spare on system power supplies.

1.05 SEQUENCE OF OPERATION

- A. For system description of output controls and monitoring, based on input signals, refer to Sequence of Operation Matrix on the Drawings.

- B. General alarm operation: Upon alarm activation of any area smoke detector, duct smoke detector, heat detector, manual pull station, sprinkler waterflow, etc., the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel and annunciator.
 2. The LCD Display shall indicate all applicable information associated with the alarm condition including zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.
 4. The following notification signals and actions shall occur simultaneously:
 - a. Horns shall sound throughout the building.
 - b. An evacuation message shall be sounded on fire floors (zones). The signal shall be a slow whoop tone.
 - c. Activate visual strobes throughout the building.
 - d. Activate visual strobes on the fire floors (zones). The visual strobe shall stop operating when the "Alarm Silence" is pressed.
 5. Transmit signal to the central station with point identification.
 6. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
- C. Trouble operation: Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:
1. The internal audible device shall sound at the control panel and annunciator.
 2. The LCD keypad display shall indicate all applicable information associated with the trouble condition including zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
 4. Transmit signal to the central station with point identification.
- D. In addition to the above sequence of operation, the FACP shall perform the following functions:
1. Identify every addressable device by location, priority, and device type.
 2. Read and display at FACP the sensitivity of addressable smoke and heat detection devices.
 3. Remain 100% operational and capable of responding to an alarm condition while in the routine maintenance mode.
 4. Be capable of supporting non-addressable as well as addressable devices.
 5. Allow individual programmable control of each connected remote or panel-mounted relay.
 6. Provide the user with the field programmability to add or change addressable device types and custom messages on-site.

7. Display up to 127 alarms and/or up to 127 trouble indications, one at a time, as a list on the system printer/terminal.
8. Change the status of configured circuits (arming or disarming) and change status of relays.
9. Generate an addressable detector sensitivity report providing a chamber voltage listing (device testing) for each detector

1.06 SUBMITTALS

- A. Submit in accordance with the requirements of Section 280010: Basic Electronic Safety and Security Requirements, the following items:
 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 2. Describe system operation, equipment and dimensions and indicate features of each component.
 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 4. Shop Drawings. A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:
 - a. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials.
 - b. Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
 - c. A riser diagram that individually depicts all control panels, annunciators, addressable devices, and notification appliances. Field addressable devices and notification appliances may be grouped together by specific type per loop or circuit.
 - d. Complete 1/8" = 1'-0" scale floor plan drawing locating all system devices and elevation of all equipment. Floor plans shall indicate accurate locations for all control and peripheral devices as well as raceway size and routing, junction boxes, and conductor size, and quantity in each raceway. All notification appliances shall be provided with a candela rating and circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.
 - e. Control panel wiring and interconnection schematics. The drawing(s) shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data-gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service, and location of the control enclosure.

- f. Complete calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws.
- g. System (Load & Battery) calculations shall be provided for each system power supply, each notification appliance circuit and each auxiliary control circuit that draws power from any system power supply.
- h. Additionally, Drawings shall include:
 - 1) Symbols legend.
 - 2) Equipment list showing quantity, make, model and CSFM listing number for each device.
 - 3) Wire and cable schedule.
 - 4) Scope of Work with overall system description.
 - 5) Sequence of operation matrix with system inputs signals and output functions.
 - 6) Code summary and Building type.
 - 7) Assignment of Class and/or Style designation for device circuits.
 - 8) Elevation indicating mounting heights for manual pull stations, audible and visual devices, and combination audible/visual devices.
 - 9) Rated penetration details.
 - 10) Typical wiring diagram details of field devices.
 - 11) Detector mounting details at HVAC ducts.
 - 12) Voltage drop calculations for system wiring circuits.
- 5. Furnish structural calculations for equipment anchorage as described in Section 280010: Basic Electronic Safety and Security Requirements.
- 6. Submit Manufacturer's installation instructions.
- 7. Complete bill of materials listing all components.
- 8. Installer's NICET 3 Certification.
- 9. Letter or Certificate from the fire alarm manufacturer stating that the fire alarm contractor is an authorized Strategic Partner of the specified product.
- 10. Warranty.
- B. Record Drawings:
 - 1. Furnish Record Drawings as described in Section 280010: Basic Electronic Safety and Security Requirements, utilizing Shop-Drawing submissions with updated field conditions. These Drawings shall include but not be limited to the following:
 - a. Plot plans and building floor plans, showing point-to-point wiring location of and conduit routing to all devices.

- b. Block Diagram/Riser Diagram showing the FACP, system components and all conduit and wire type/sizes between each.
2. Drawings shall be incorporated into the Record Drawing submission.
3. Final acceptance will not be made until the Engineer has approved the Record Drawings.

1.07 OPERATION AND MAINTENANCE MANUAL

- A. Supply operation and maintenance manuals in accordance with the requirements of Section 280010: Basic Electronic Safety and Security Requirements, to include the following:
 1. A detailed explanation of the operation of the system.
 2. Instructions for routine maintenance.
 3. Pictorial parts list and part numbers.
 4. Schematic Drawings of wiring system, including all initiation and annunciation devices, control panel, annunciators, etc.
 5. Telephone numbers for the authorized parts and service distributors.
 6. Final testing reports.

1.08 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new, unused, and currently under production.
- B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.
- C. All work in this Section shall be performed (furnished, installed, connected, programmed, and tested) by a qualified fire alarm contractor. The fire alarm contractor shall provide the following documentation to show compliance with the contractor qualifications.
 1. Contractor's License: A copy of the contractor's valid State License. The contractor must be licensed in the State where project is located and have been in business in that State for a minimum of 5-years.
 2. Proof of Experience: Proof that the fire alarm contractor has successfully installed similar fire alarm systems on a previous project of comparable size and complexity. Provide a statement summarizing any pending litigation involving an officer or principal of/ or the company, the nature of the litigation and what effect the litigation may carry as it relates to this work in the worst-case scenario. Non-disclosure of this item, if later discovered, may result, at the Owner's discretion, in termination of this contract with the contractor bearing all associated costs.
 3. Insurance Certificates: Copy of fire alarm contractor's current liability insurance and state industrial insurance certificates in conformance with the contract document.
 4. Service Capability: The fire alarm contractor shall have in-house Engineering, installation, and service personnel with a maintenance office within 50-miles of the project location

5. Authorization Letters: Letters from the fire alarm equipment manufacturer stating that the fire alarm contractor is a Factory Authorized Distributor and is trained and certified for the equipment proposed on this project and is licensed to purchase and install the software required to provide the specified functions.
6. Certifications:
 - a. Provide a copy of the National Institute for Certification in Technologies (NICET) Technician Level 3 Certificate for the employee actively involved in this project.
 - b. Documentation that the fire alarm contractor has on staff personnel factory-trained and certified for the equipment proposed for this project.

1.09 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: Fire alarm system components shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.
- B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.
- C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.10 WARRANTY

- A. Units and components offered under this Section shall be covered by a 1-year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner.
- B. The warranty package shall include, but not be limited to the following:
 1. Emergency maintenance service.
 2. Service by factory trained service representative of system Manufacturer.
 3. Replacement of any defective components.

1.11 SYSTEM START-UP

- A. Upon completion of installation, a factory trained dealer service representative shall perform initial start-up of the fire alarm system. Sufficient time shall be allowed to properly check the system out and perform required minor adjustments before the Engineer's witnessed test shall begin.

1.12 MAINTENANCE

- A. Extra Material:
 1. Provide the following fire alarm system components as extra materials, matching the products installed and packaged for storing.

- a. Detectors: Furnish a quantity equal to 10 percent, for each type of the number installed.

B. Maintenance Service:

1. For a period of one year following acceptance the equipment Supplier shall have a person(s) familiar with this Project attend four quarterly meetings with the Owner's Representative to review system performance, operation, and any system problems. That person shall provide a written summary of the items discussed in each meeting and a schedule of when the system problems will be corrected. The report is due within 7 working days after each meeting.
2. During the eleventh month following system acceptance, on a weekend day, the equipment Supplier shall perform a complete test of the system, in a manner similar to the acceptance test. A written report shall be submitted to the Owner certifying that each initiating device has been tested. A copy of these test forms shall be submitted to the Engineer for review and acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.
1. Silent Knight.
 2. Gamewell/FCI (Fire Control Instruments).
 3. Notifier.
 4. Siemens.
- B. Substitutions: Under provisions of Section 280010: Basic Electronic Safety and Security Requirements.

2.02 CONTROL PANEL 'FACP'

- A. General:
1. The control panel shall comply with applicable requirements of UL864 and shall provide power, annunciation, supervision, and control for the complete fire alarm system. The panel shall be installed in a surface mounted steel cabinet, containing all modules necessary to operate as indicated herein. The operating controls shall be located behind hinged, locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.
 2. The panel shall be supervised, site programmable, and of modular design supporting up to 64 network nodes. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, and annunciation nodes. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes. When utilizing a network and multiple wiring faults occur, the network shall re-configure into many sub-networks and continue to respond to alarm events from every panel that can transmit and receive network messages.

3. The panel module shall control and monitor all local or remote peripherals. It shall support a large 168-character LCD, power supply, remote LCD and zone display annunciators, printers, and support communication standard interface protocol (CSI) devices such as color computer annunciators and color graphic displays, etc.
4. Each controller shall contain a RS232 programming port for programming locally via an PC. When operational, each controller shall support a printer through the RS232 port and be capable of message routing.
5. The programmer shall be able to download all network applications from the configuration computer to all the network panels from a single location on the system.
6. The panels shall have the ability to add an operator interface control/display at each node that shall annunciate, command and control system functions.
7. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact.
8. The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.
9. All addressable devices shall be individually identified by the system and any quantity of addressable devices may be in alarm at any time up to the total number connected to the system.
10. Dynamic supervision of system electronics, wiring, initiating devices and software shall be provided by the control system. Failure of system hardware or wiring shall be indicated by type and location on the alphanumeric annunciator. Software and processor operation shall be monitored by an independent hardware watchdog, which will indicate their failure. The panel shall provide failsafe operation, i.e. all incoming alarms shall override all other modes of operation.
11. Provide a service mode to permit the arming and disarming of individual initiating or output devices as well as manually operating output devices. Status of these devices shall be displayed upon command from the control panel. The panel shall automatically return to the normal mode in the event the panel remains unattended in the service mode.
12. The panel shall be capable of measuring and adjusting the sensitivity of addressable detectors upon request. An alphanumeric display shall be provided to display custom messages and give readings of detector sensitivity detector by detector. Each device on an addressable initiating circuit shall be checked continuously to include the following:
 - a. Sensitivity.
 - b. Response.
 - c. Opens.
 - d. Shorts.

- e. Ground faults.
 - f. Functionality.
 - g. Status.
13. The panel shall monitor the addressable smoke detectors in such a manner that if the detectors become dirty and reach and maintain 80% of alarm threshold for 5-consecutive hours, a trouble condition indicating exactly which device needs service shall be automatically annunciated. If the device becomes too insensitive for a period of 10-seconds, the trouble indication will read: "Input device response too low".
 14. The panel shall report, by specific device number, any device removed from an addressable initiating circuit and all other devices shall continue to function.
 15. The panel shall automatically indicate the total quantity of alarms and troubles, which have occurred prior to reset at the control unit.
 16. No alarm or trouble indication shall be resettable until it has been acknowledged. It shall not be possible to reset the system until all alarms have been acknowledged.
 17. The panel shall be capable of:
 - a. Counting the number of addressable devices within a designated area or "zone" which are in alarm.
 - b. Counting "zones" which are in alarm.
 - c. Counting the number of addressable devices, which are in alarm on the system.
 - d. Differentiating among types of addressable devices such as smoke detectors, manual stations, waterflow switches, heat detectors, etc.
 - e. Assigning priorities to types of devices, zones, or groups of devices.
 - f. Cross-Zoning.
 18. Each addressable device shall report its condition to the panel control unit every 3-seconds in a manner such that failure of the connections to or internal electronics of the device will result in a trouble signal that identifies the specific device involved.
- B. Signaling line circuits (SLC):
1. The control panel shall be supervised, site programmable, and of modular design supporting up to 125-detectors and 125-remote modules per addressable SLC. The panel shall support up to 10-SLC's per panel for a total system capacity of 2500-intelligent addressable points. The system shall be designed with peer-to-peer networking capability for enhanced survivability, with support for up to 64 nodes, each with up to 2500-points and an overall capacity of 160,000-points.
 2. The system shall provide electronic addressing of analog/addressable devices.
 3. The system shall have built-in automatic system programming to automatically address and map all system devices attached to the main controller.

4. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.
 5. The system shall have a UL Listed detector sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4-hours.
- C. Digital alarm communicator transmitter (DACT):
1. The system shall provide DACT for off premise communications capability, transmitting system events to single or multiple Central Monitoring Station (CMS) receivers.
 2. The system shall be capable of providing the CMS with point identification of system events using Contact ID or SIA DCS protocols.
 3. In the event of a panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.
- D. Internal Modular Power Supply:
1. System power supply(s) shall provide multiple power limited 24volt DC output circuits as required by the panel.
 2. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functions.
 3. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
 4. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciate as battery trouble and identify the specific power supply affected.
 5. All system power supplies shall be capable of recharging up to 260AH batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
 6. Power supply shall be adequate to supply all system components of the fire alarm system, including FACP modules, initiating devices, notification appliances, remote control and monitoring devices, annunciators, etc. All power connections whether AC or DC shall be separately fused within panel.
- E. Reports:
1. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD and shall be capable of being printed on any system printer.
 2. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system

shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any detector.

3. The system shall provide a report that gives a listing of the sensitivity of all the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
4. The system shall provide a report to determine the carbon monoxide detectors end-of-life.
5. The system shall provide a report that gives a chronological listing of up to the last 1740 system events.
6. The system shall provide a listing of all the firmware revision listings for all the installed network components in the system.

2.03 ANNUNCIATORS

A. Main control and annunciator panel:

1. Main annunciator shall be located with the FACP.
2. The main display shall be a large 168-character LCD with normal, alarm, trouble, supervisory, disabled point, and ground fault indicators.
3. The main display shall show the first and most recent highest priority system events without any operator intervention. All system events shall be directed to one of four message queues. Messages of different types shall never inter-mixed to eliminate operator confusion. A "Details" switch shall provide additional information about any device highlighted by the operator.
4. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85-dBA at 10-feet.
5. The internal audible signal shall have different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
6. The annunciator shall contain the following controls:
 - a. System reset switch with indicator
 - b. System alarm silence switch with indicator
 - c. System panel silence switch with indicator
 - d. Programmable switch with indicator
 - e. Details switch
 - f. System message queue scroll switches.
 - g. 10-Digit keypad to enable/disable system and functions.
7. An authorized operator shall have the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
8. An authorized operator shall be capable of performing test functions within the installed system.

B. Fireman's remote annunciator panel (FRAP):

1. Remote LCD network alphanumeric annunciators shall display each point in the system.
2. Network alphanumeric annunciators shall be located as indicated on the plans. This annunciator shall be an integral part of the peer-to-peer network for survivability.
3. Annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm, or supervisory functions on a by point or by geographic area. The annunciators shall be mounted in stand-alone enclosures at location as indicated on the plans.

2.04 INTELLIGENT ADDRESSABLE DETECTORS**A. General:**

1. Each detector device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Devices shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller.
2. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.
3. The intelligent detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns, and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.
4. Each detector shall be capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Maximum total analog loop response time for detectors changing state shall be 0.75-seconds. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data.
5. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging, and humidity.
6. Each detector shall have a separate means of displaying communication and alarm status. A green/red LED shall flash to confirm communication with the analog loop controller and display alarm status.

7. The detector shall be capable of identifying up to 32-diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.
 8. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of 5-sensitivity settings.
 9. Each device microprocessor shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long-term and 4-hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
- B. Photoelectric smoke detector:
1. Provide intelligent analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings.
 2. Each unit shall have a field-replaceable smoke chamber.
 3. The photo detector shall be rated for ceiling installation at a minimum of 30-foot centers and be suitable for wall mount applications.
 4. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3-feet high and 3-feet wide with air velocities up to 5,000-feet/minute.
 5. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photoelectric detector shall be suitable for operation in the following environment:
 - a. Temperature: 32-degree F to 120-degree F (0-degree C to 49-degree C)
 - b. Humidity: 0-93% RH, non-condensing
 - c. Installation attitude: no limit
- C. Standard detector bases:
1. Provide standard detector mounting bases suitable for mounting on a standard 4" octagon or square box. The base shall contain no electronics and support all intelligent detector types.
 2. Removal of the respective detector shall not affect communications with other detectors.
 3. Terminal connections shall be made on the room side of the base.

D. Synchronized signal module:

1. Provide intelligent single input signal modules for activation of booster power supplies and/or audible/visual circuits that require synchronization.
2. The single input signal module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation.
3. The module shall be suitable for mounting on a standard 4" square box with 2-gang ring.
4. The single input signal module shall support audible/visible signal power selector (polarized 24volt DC at 2amp, 25Vrms at 50watt or 70Vrms at 35watt of audio)
5. Provides UL1971 auto-sync output for synchronizing multiple notification appliance circuits

2.05 NOTIFICATION APPLIANCES**A. Horns:**

1. Horns shall be a low-profile design, finished in red with white lettering and shall not protrude more than 1" off the finished wall surface. In-out screw terminals shall be provided for wiring.
2. Horns shall be provided with a switch selectable audible output of at least two decibel levels. Maximum 84-dBA output at 10-feet when measured in reverberation room per UL 464.
3. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.
4. Horns shall be suitable for wall mounting and shall mount in a standard 4" square x 2 1/8" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
5. Horns shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 2-1/8" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
6. Where surface mounted horns are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.
7. ceiling.

B. Strobe lights:

1. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2-seconds. The light output shall be an even pattern with no hot spots. Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.
2. The strobe shall have selectable 15, 30, 75 or 110 cd settings for wall or standard ceiling height mounting.
3. The strobe shall have selectable 95, 115, 150 or 177 cd settings for high ceilings.

4. It shall be possible to change the strobe setting without removing the device from the wall or ceiling.
5. Strobes shall be suitable for wall mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
6. Strobes shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
7. Where surface mounted strobe lights are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.

C. Combination horn/strobe lights:

1. Horns shall be a low-profile design, finished in red with white lettering and shall not protrude more than 1" off the finished wall surface. In-out screw terminals shall be provided for wiring.
2. Horns shall be provided with a switch selectable audible output of at least two decibel levels.
3. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.
4. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2-seconds. The light output shall be an even pattern with no hot spots.

Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.

5. It shall be possible to flash the strobe at a temporal flash rate to match the horn.
6. The strobe shall have selectable 15, 30, 75 or 110 cd settings for wall or standard ceiling height mounting.
7. The strobe shall have selectable 95, 115, 150 or 177 cd settings for high ceilings.
8. It shall be possible to change the strobe setting without removing the device from the wall or ceiling.
9. Horn/strobes shall be suitable for wall mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
10. Horn/strobes shall also be suitable for ceiling mounting and shall mount in a standard 4" square x 1-1/2" deep electrical box. All mounting hardware shall be captive and there shall be no mounting screws visible after the device is installed.
11. Where surface mounted horn/strobe lights are installed a skirt enclosure or manufacturer's color-matched surface mount box, shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall or ceiling.

12. Appliances shall be a semi-flush design, finished in red with white lettering. In-out screw terminals shall be provided for wiring.
 13. Horns shall be provided with a switch selectable audible output of at least three decibel levels of 99, 95, and 90-dBA.
 14. Horns shall have two selectable tone options of temporal or non-temporal continuous pattern.
 15. Strobes shall provide synchronized flash outputs at maximum pulse duration of 0.2 seconds. The light output shall be an even pattern with no hot spots. Strobes appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.
 16. The strobe shall have a 75 cd setting for wall or standard ceiling height mounting.
 17. Strobe shall operate over an extended temperature range of -31-degree F to 150-degree F. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring.
 18. Appliance backbox shall be weatherproof and vandal resistant.
- D. Remote booster power supplies:
1. Unit shall be a self-contained with 24volt DC power supply and batteries housed in its own locked enclosure. Keys provided shall be identical to the keys provided for all other fire alarm equipment provided.
 2. Power supply shall be available in both 10amp or 6.5amp models and 120volt AC.
 3. On board LED indicators for each NAC, battery supervision, ground fault and AC power.
 4. The power supply shall provide four (4) independent 3amp NACs. Each circuit can be configurable as an auxiliary output.
 5. Configurable for any one of three signaling rates: 120SPM; 3-3-3 temporal; or, continuous.
 6. Two independent and configurable inputs switch selectable to allow correlation of the two (2) inputs and the four (4) outputs.
 7. NACs shall be configurable for either four Class B or two Class A circuits.
 8. The unit shall be compatible with SIGA-CC1S for synchronization of multiple power supplies without inter-connect wiring.
 9. Brackets shall be provided inside the enclosure to allow mounting the signaling modules. All signaling modules shall be listed to be located inside the booster power supply enclosure.
 10. A selectable dip switch shall enable built in synchronization for horns and strobes which may be used to synchronize downstream devices, as well as other boosters and their connected devices.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine Project site conditions for acceptance of fire alarm system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 INSTALLATION

A. General:

1. Install fire alarm system in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.
2. The 120volt, 2-wire, 60-cycles AC two-20amp circuits supply required to power the system shall be connected as indicated on the Drawings. Connect to red colored circuit breaker(s) in panelboard. Identify circuit as "Fire Alarm Circuit Control."

B. Conductors:

1. Refer to Section 280513: Electronic Safety and Security Conductors and Cables.
2. All circuits shall be rated power limited in accordance with CEC Article 760.
3. All system conductors shall be of the type(s) specified herein.
 - a. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.
 - b. All wiring shall be color-coded throughout.
 - c. Signaling line circuits: Shall be #18 AWG minimum multi-conductor jacketed twisted cable or as per manufacturer's requirements.
 - d. Initiating device circuits: 24volt DC circuits shall be #18 AWG minimum or per manufacturer's requirements.
 - e. Notification appliance circuits:
 - 1) Horn-strobe or strobe: Non-twisted pair, not less than #14 AWG or as recommended by the manufacturer.
 - f. 120Vac circuits:
 - 1) Minimum #10 AWG for panel power circuits.
 - 2) Minimum #12 AWG for all other circuits.
 - 3) Each circuit shall have its own dedicated neutral conductor.

C. Conduit raceway:

1. All system components listed to UL864 Control Units for Fire Protective Signaling Systems shall be installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.
2. All system conduits shall be EMT, 1/2-inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 1/2-inch diameter, minimum.

3. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.
4. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with other building systems, facilities or equipment, and to facilitate service and minimize maintenance.
5. All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures, and device back boxes shall be readily accessible for inspection, testing, service and maintenance.
6. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.
7. All junction box covers shall be painted red.

D. Equipment:

1. All devices and appliances shall be mounted to flush mounted boxes where areas are finished. Exceptions being above suspended ceiling, exposed ceiling areas, or equipment rooms to facilitate connections to other equipment.
2. All audio/visual devices shall be mounted at a minimum of 80-inches and no more than 96-inches above the finished floor, as measured on strobe center. Devices shall be mounted no less than 6-inches from the ceiling.
3. No area smoke detectors shall be mounted within 36-inches of any HVAC supply, return air register or luminaire.
4. No area smoke or heat detector shall be mounted within 12-inches of any wall.
5. All fire alarm devices shall be accessible for periodic maintenance.
6. End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled so removal of the device is not required to identify the EOL device.
7. All addressable modules shall be mounted within 36-inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.
8. Power-limited/non-power-limited CEC wiring standards shall be observed.
9. Relays shall be appropriately labeled on the exterior to indicate "FIRE ALARM SYSTEM" and their specific function (i.e. FAN SHUTDOWN).

3.03 FIELD QUALITY CONTROL

- A. Refer to Specification Section 280800: Electronic Safety and Security Commissioning.
- B. Manufacturer's field service: Contractor shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start-up, pretesting, and adjustment of the fire alarm system.

- C. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control testing, calibration and inspection required herein. Testing Agencies objectives shall be to:
1. Assure fire alarm system installation conforms to specified requirements and operates within specified tolerances.
 2. Field test and inspect to ensure operation in accordance with Manufacturer's recommendations and Specifications.
 3. Prepare final test report including results, observations, failures, adjustments, and remedies.
 4. Apply label on fire alarm system control panel upon satisfactory completion of tests and results.
 5. Verify settings and make final adjustments.
- D. Engineer witnessed testing: Allow a period of 8 hours for Engineer review and final check.
- E. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.
- F. Prefunctional testing:
1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.
 2. Visual and mechanical inspection:
 - a. Inspect for physical damage, defects alignment and fit.
 - b. Perform mechanical operational tests in accordance with Manufacturer's instructions.
 - c. Compare nameplate information and connections to Contract Documents.
 - d. Check tightness of all control and power connections.
 - e. Check that all covers, barriers, and doors are secure.
 3. Fire alarm system tests:
 - a. The system shall be completely tested prior to final acceptance testing. All points shall be tested from point of initiation to the final point or points of annunciation. All circuits shall be tested for continuity and ability to transmit the required signal correctly to the FACP. Any problem due to wrong wire type, wire twist, impedance, mismatches, noise filtering or shielding shall be completely corrected during pretesting and prior to any final acceptance tests.
 - b. Testing shall include each device in the system. Coordinate with other trades as necessary for testing.
 - 1) Smoke detectors, in-duct smoke detectors and duct mounted smoke detectors: Test with actual or approved artificial smoke. Verify that reset does not occur when devices are cleared of smoke. Verify supervisory circuit function. Perform pressure differential test on all duct mounted smoke detectors.

- 2) Audible/visual notification: Activate by means of an alarm-initiating device that audible and visual devices are clearly audible and/or visual throughout.
- 3) Central station notification: Verify that one set of conductors in the terminal cabinet becomes a short circuit on any "trouble" condition and that the other set becomes a short circuit on any "alarm" condition. Verify that the conductor groups are labeled properly.

c. Test report:

- 1) Provide a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
- 2) Submit two typed copies of the test report in a neatly bound folder for review and approval. Failure to comply with this will result in a delay of final testing and acceptance.

G. Functional performance testing:

1. Refer to Specification Section 280800: Electronic Safety and Security Commissioning for requirements of system wide functional performance testing.
2. After the approval of the test report, provide a schedule of final testing to be done in the presence of the Fire Marshal and Owner's Representative. The schedule must be received by the Engineer a minimum of 2 weeks prior to the Final Test Date and must list the dates and time slots in which the various systems can be tested.
3. Coordination of the Final Test dates with all parties (General Contractor, Mechanical Contractor, Elevator Contractor, Engineer, Owner, and others) shall be the sole responsibility of the Contractor. If a party is required to be present during any phase of testing to activate a device, ensure that the party or a qualified representative of the party is present throughout that phase of the testing.

H. In the event that the system fails to function properly during the testing, as a result of inadequate pretesting or preparation, the Contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Engineer's hourly rate.

I. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.

J. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies, and remedies. Test report shall be included in the operation and maintenance manuals.

3.04 TRAINING

A. Refer to Specification Section 280800: Electronic Safety and Security Commissioning.

B. Factory authorized service representative shall conduct a 8-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions

shall include safe operation, maintenance, and testing of equipment with both classroom training and hands-on instruction.

C. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION 283100

Draft
(Not for Bidding)

DIVISION XIII LEVEE CONSTRUCTION

100 LEVEE PROVISIONS

EXISTING FACILITIES – SUBSURFACE DATA

12.1-1 GENERAL

12.1-1.1 SCOPE

This section describes the available subsurface data, intent of data for use, and Contractor's responsibility as it relates to this data.

12.1-2 PRODUCTS

Not used.

12.1-3 EXECUTION

12.1-3.1 AVAILABLE SUBSURFACE SOIL DATA

12.1-3.1.1 SUBSURFACE DATA ATTACHMENT

Subsurface conditions are presented in the attached geotechnical data report (Geotechnical Data Report, I-Street Bridge Replacement Project, GEI, April 2025), submitted as a reference to these specifications and includes boring logs and locations, subsurface profile, exploratory trench logs, and laboratory data. Data on subsurface conditions shown in the drawings or specifications may not necessarily be representative across the site, since they are based on discrete locations. The water levels shown on the logs of explorations are those measured at the time of drilling. As the water table is related to the river stage, the water table is expected to change during the construction period.

12.1-3.2 ADDITIONAL INVESTIGATION

12.1-3.2.1 SUBSURFACE MATERIALS

As required by Section 2-1.07 of the Caltrans Standard Specifications, it is the Contractor's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials to be encountered, by inspecting the site and by evaluating information derived from exploratory work that may have been accomplished by others or included in these Contract Documents. Any failure to become acquainted with all the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the work.

12.1-3.2.2 SUBMISSION OF BID

The submission of a bid is conclusive evidence that the prospective bidder has reviewed the site conditions, and is satisfied as to the character, quality, and quantities of work to be performed and materials to be furnished, and as to the requirements of the Contract Documents.

EXISTING FACILITIES - SUBSURFACE DRILLING, SAMPLING, AND TESTING

12.2-1 GENERAL

12.2-1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1452 (2024) Soil Investigation and Sampling by Auger Borings

ASTM D1586 (2022) Penetration Test and Split-Barrel Sampling of Soils

ASTM D1587 (2008) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

ASTM D2488 (2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

ASTM D6914 (2016) Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1110-1-1807 (2023) Drilling and Invasive Activities at Dams and Levees

12.2-1.2 SYSTEM DESCRIPTION

12.2-1.2.1 ADDITIONAL GEOTECHNICAL DATA

The Contractor must provide at its own expense whatever additional subsurface investigation is required along the levee or in borrow areas to further define the nature of the materials and obtain additional samples of material for testing or trial mixes, so that the work can be properly planned and executed. At a minimum, the investigation program shall include a total of four exploratory borings to be located along the proposed cutoff wall alignment and extend to a sufficient depth to demonstrate key-in confirmation for the cutoff wall. This is to be accomplished by means of auger borings, drive sample borings, sonic borings, undisturbed sample borings, or test pits. A drilling and invasive program plan (DIPP) prepared in accordance with ER 1110-1-1807 (Drilling in Earthen Embankment Dams and Levees) must be submitted for review and approval at least 90 days prior to any drilling, sampling, grouting, excavating or any other invasive in-situ testing or explorations. A hydraulic fracture analysis is required for the grout column for hole completion. If drilling fluids are anticipated during explorations, a hydraulic fracture analysis must be performed for use of drilling fluids. Specific requirements for the DIPP are included in Section 6 and Appendix B of ER 1110-2-1807, and Paragraph 12.2-1.3.1 Drilling and Invasive Program Plan (DIPP). The Drilling and Invasive Program Plan must be submitted to the Government by the Contractor's Professional Engineer who is licensed in the State of California. The work must be executed as specified herein and copies of all

boring logs, test pit logs, and laboratory test results must be provided to the Government to be made part of the project record.

12.2-1.2.1.1 PRE-BID SUBSURFACE INVESTIGATION

The prospective bidders may perform subsurface investigations at their own expense prior to the date bids are received to expand the site characterization and subsurface conditions data, but only after receiving the necessary clearance from the Government and rights-of-entry from property owners. All work must be performed in accordance with applicable laws and regulations, such as USACE Engineering Regulation 1110-1-1807. Results of subsurface exploration performed by bidders, including soil classification logs and laboratory data, must be submitted to the Government following bid opening to become part of the Project record.

12.2-1.2.2 AUGER BORING AND SAMPLING

An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Auger boring and sampling must be performed in accordance with ASTM D1452, or as directed by the Government.

12.2-1.2.3 DRIVE SAMPLE BORINGS AND SAMPLING

A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Standard Penetration Tests (SPT) must be performed in accordance with ASTM D1586.

12.2-1.2.4 UNDISTURBED SAMPLE BORINGS AND SAMPLING

An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. All undisturbed sampling must be accomplished in accordance with ASTM D1587, or as directed by the Government.

12.2-1.2.5 SONIC BORINGS AND SAMPLING

A sonic boring is any boring made in unconsolidated soils with drilling equipment that utilizes high frequency vibration aided by down pressure and rotation to advance drilling tools through various subsurface formations for the purpose of obtaining a nearly continuous column of subsurface materials. Sonic boring and sampling must be performed in accordance with ASTM D6914, or as directed by the Government

12.2-1.2.6 TEST PIT EXCAVATION SAMPLING

A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and

geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. All test pits must be excavated, dewatered (if necessary), shored/lined and protected from surface water drainage and backfilled in accordance with all applicable Federal and State safety regulations.

12.2-1.3 SUBMITTALS

The following must be submitted in accordance with Caltrans Standard Specifications Section 5-1.23 SUBMITTALS:

SD-01 Preconstruction Submittals

Drilling and Invasive Program Plan (DIPP); G

SD-02 Shop Drawings

Drilling and Test Pit Log

SD-07 Certificates

Permits, Certifications, and Licenses

12.2-1.3.1 DRILLING AND INVASIVE PROGRAM PLAN (DIPP)

The Contractor must submit a plan for drilling, sampling, testing, excavating, and safety prepared in accordance with USACE Engineering regulation ER 1110-1-1807. The plan must include, but must not be limited to, the proposed method of drilling including a description of the drilling or excavation equipment, proposed method of sampling including sampler type and size, and the proposed exploration plan including number, location, depth, diameter, bearing and inclination of the proposed borings. Additionally, the Contractor must submit the depth at which samples will be taken, the reason for the sample, and any proposed laboratory testing that will be performed on the sample.

This submittal must also include the name and a statement of the prior experience, in the type of work described in these specifications, of the drill rig or excavation equipment operator designated to perform the work specified herein. This submittal must also include the name, organization, title, registration and a statement of the prior experience, in the type of work described in these specifications, of the field supervision personnel and the personnel responsible for logging materials designated to perform the work specified herein.

This submittal must also include monitoring needs during drilling, and an emergency action plan including a list of emergency equipment and supplies to have onsite. No work must be performed until this plan has been reviewed and accepted by the USACE and no deviation from the reviewed plan will be permitted without prior review by the Government.

The Contractor must submit complete, legible copies of DRILLING LOG, TEST PIT LOGS, and records to the Government within 2 days after a hole or test pit is completed.

12.2-1.3.3 PERMITS, CERTIFICATIONS, AND LICENSES

Copies of all permits, certifications, and licenses must be submitted prior to starting work.

12.2-1.4 CARE AND DELIVERY OF SAMPLES

12.2-1.4.1 GENERAL

The Contractor must be solely responsible for preserving all samples in good condition.

12.2-1.4.2 UNDISTURBED SAMPLES

Every precaution must be taken to avoid damage to samples as a result of careless handling and undue delay in shipping. Samples must be shipped in containers and must be of sufficient durability to protect the samples from any damage during shipment. The sample tubes must be well packed in vermiculite or other equal material reviewed by the Government to protect the samples against vibration. The Contractor must avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 100 degrees F. In general, no undisturbed samples must remain on the site of sampling for more than one week before shipment. Samples must be stored and shipped with the tube in a vertical position in order to prevent consolidation, segregation, and change in moisture content.

12.2-1.5 PROJECT/SITE CONDITIONS

12.2-1.5.1 ENVIRONMENTAL REQUIREMENTS

In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and its subcontractors must comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.

12.2-2 PRODUCTS

12.2-2.1 CONTAINERS

The Contractor must furnish jars, tubes, and core boxes for the storage and shipment of samples. The Contractor must be responsible for the disposal of the jars, tubes and core boxes used during construction.

12.2-2.1.1 SAMPLE JARS

Sample jars must be 1 pint capacity, wide-mouth glass jars with moisture-tight screw tops.

12.2-2.1.2 SHIPPING BOXES

Boxes for shipping sample jars must be corrugated cardboard boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.

12.2-2.1.3 TUBES AND CRATES

Undisturbed samples must be shipped in thin walled Shelby tubes packed in crates.

12.2-2.1.4 CORE BOXES

Use longitudinally partitioned, hinged top, wooden core boxes constructed of plywood and dressed lumber or other approved materials for all rock cores. As many core boxes as may be required must be used to box all core. Furnish core boxes completely equipped with all necessary partitions, hinges, and a hasp for holding down the cover. Also provide wood spacers made of surfaced lumber (not plywood) and having dimensions that are 1/8 inch less than the inside dimensions of the individual core box troughs and no less than 3/4 inch thick for blocking the core in the boxes and for providing a marking space to identify core runs and pull depths/elevations. The quantities of these blocks that are required are: ten blocks per core box for 3 inch or smaller core, five blocks per core box for 4 inch and PQ core, and three blocks per core box for 6 inch core. The box should have the following capacities:

BOX CAPACITIES	
6-inch core	single row of core
4-inch or PQ core	2 rows of core
3-inch or smaller core	3 or 4 rows of core

The maximum length of a core box must be 4 feet for 3 inch or smaller core and must be dimensioned so that a box will hold 12 to 16 feet of core. The maximum length of a core box for core that is larger than 3 inches must be 5 feet.

12.2-2.2 LABELS

12.2-2.2.1 SAMPLE JAR LABELS

A printed or type-written, fade resistant and waterproof label must be affixed to the outside of each jar and must contain the following information:

PROJECT _____ LOCATION _____
(Such as Table Rock Dam) (Such as Borrow Area B)

HOLE NO. _____ STATION _____

JAR NO. _____ of _____ JARS

TOP ELEV. OF HOLE _____ DEPTH OF SAMPLE _____

DESCRIPTION OF MATERIAL _____

(Such as Moist, silty, medium sand)

12.2-2.2.2 SHIPPING BOX LABELS

Each box of jar samples must be identified with weatherproof and wear-proof labels indicating the following:

PROJECT: _____

LOCATION: _____

JAR SAMPLES FROM HOLE OR HOLES: _____

12.2-2.2.3 CORE BOX LABELS

Core boxes must be identified with stenciled labels. The information on this label must contain the following:

PROJECT	_____
HOLE NO.	_____
BOX NO.	_____
TOTAL NUMBER OF BOXES FOR THE HOLE	_____

12.2-3 EXECUTION

12.2-3.1 SUBSURFACE DRILLING MOBILIZATION AND DEMOBILIZATION

12.2-3.1.1 MOBILIZATION

Mobilization must consist of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.

12.2-3.1.2 DEMOBILIZATION

Demobilization must consist of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Government, the cleanup and removal of all scrap, waste backfill material, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

12.2-3.2 EQUIPMENT AND SUPPLIES

12.2-3.2.1 AUGER BORING AND SAMPLING

The equipment to be furnished by the Contractor for making auger borings must include, but not be limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or equal to the Iwan Auger and not less than 4 inches in

diameter unless otherwise approved. The augers must be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the Plans.

12.2-3.2.2 DRIVE SAMPLE BORING AND SAMPLING

Equipment to be furnished by the Contractor for making drive sample borings must include, but not be limited to, SPT 2-inch Outside Diameter (OD) split barrel drive sampler, Modified California 3-inch OD split barrel drive sampler, and power-driven drilling machinery of a type or types reviewed by the Government, complete with a drive-hammer of 140-pound weight and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths required. The drive shoe for the split barrel samplers must be of hardened steel and must be replaced or repaired when it becomes dented or distorted. Supplies must include, but not be limited to, all casing, drill stem, drill bits, pumps, and power necessary to accomplish the required boring and sampling.

12.2-3.2.3 UNDISTURBED SAMPLE BORING AND SAMPLING

Equipment to be furnished by the Contractor for making undisturbed sample borings must include, but not be limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Drilling machinery must be of the hydraulic feed type. Supplies must include, but not be limited to, all samplers, casing, drill stem, drill bits, pumps, and power necessary to accomplish the required boring and sampling. Drill casing, if used, must be of such minimum inside diameter as to allow use of the selected sampler.

- a. Soft Cohesive Soils: The sampling device used to sample soft cohesive soils must be a fixed or stationary piston type that uses a 3-inch diameter thin wall Shelby tube.
- b. Stiff and Dense Soils: The sampling device for obtaining samples of stiff and dense soils must be similar or equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and must be reviewed by the Government prior to use.

12.2-3.2.4 SONIC DRILLING AND SAMPLING

The equipment to be furnished by the Contractor for making sonic borings must include, but not be limited to, the sonic rig and all accessories to perform borings of not less than 4 inches in diameter unless otherwise approved. The sonic rig must be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the Plans.

12.2-3.2.5 TEST PIT EXCAVATION AND SAMPLING

Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment must be at the Contractor's discretion but must be reviewed by the Government. The Contractor must also furnish all materials required for shoring/lining to comply with all applicable safety regulations.

12.2-3.2.6 WATER LEVEL MEASUREMENTS

Provide and maintain a portable water level measuring device of sufficient length to measure the water level to a depth of 100 feet. Have the device onsite at all times. Take water level measurements to the nearest 0.01 foot. Verify that the water level instrument is not damaged and functioning properly before proceeding with coring.

12.2-3.3 IDENTIFYING SAMPLES

Sample jars, shipping boxes, and labels must comply with PART 2, paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. In addition, a moisture proof label containing the project name, hole number and sample number must be placed inside the jar or this information can be written using a waterproof pen or scribed on the jar lid. The Contractor must take all precautions required to ensure that the shipping boxes are not subjected to rough handling or damaging environmental conditions. A copy of the boring log for the portion of the boring that the samples came from must be enclosed in the shipping box.

12.2-3.4 AUGER BORING AND SAMPLING

Samples must be labeled in accordance with paragraph IDENTIFYING SAMPLES. Samples must be obtained for each change of material type noted during drilling and at maximum vertical intervals of 5 feet. In order to retain the natural moisture content of the material to the fullest extent possible, all samples must be of sufficient volume to completely fill the sample jars and the samples must be placed in the sample jars as soon as possible after they are taken from the hole. All sample jars must be labeled.

12.2-3.5 DRIVE SAMPLE BORING AND SAMPLING

Samples must be labeled in accordance with paragraph IDENTIFYING SAMPLES. Drive sample borings drilled through overburden materials must be suitably cased to permit obtaining drive samples of the size or sizes specified or as directed. Samples must be taken either continuously or at maximum vertical intervals of 5 feet or at all changes in material type noted during drilling. The sampler must be driven with the force of the 140 pound drive hammer under a free fall of 30 inches. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, the bottom of the casing must be kept as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, samples must be obtained from a dry hole. Below the water table, water must be maintained within the hole at or above the groundwater level. The samples must be placed in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample must be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. All samples must be labeled.

12.2-3.6 SONIC BORING AND SAMPLING

Perform sonic drilling in accordance with ASTM D6914 and the requirements stated herein. Use a barrel with a split inner tube. Adjust sampling methods, sample runs, or time of sampling to maximize recovery and minimize disturbance of samples. The driller must operate the drill rig at such speeds, vibration settings, down pressures and other drill parameters to ensure maximum sample quality and recovery in whatever hardness material is encountered. The driller must exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling, and other drilling observations that, supplementing the drilling record, can augment

understanding of subsurface conditions. Place the retrieved samples neatly in partitioned boxes specified in Paragraph 12.2-2.1.4 in the same sequence they were retrieved from the hole. Label sample boxes clearly as specified herein. Take a digital photograph of each sample run clearly showing the labeled box and the sample column. When a box is full, fill the space between the sample and the sides of the box with suitable packing materials.

12.2-3.7 UNDISTURBED SAMPLE BORING AND SAMPLING

In general, labeling of undisturbed samples must conform to paragraph IDENTIFYING SAMPLES. Particular care must be taken to indicate the top and bottom of each sample tube. Tubes and crates for undisturbed samples must be labeled "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A VERTICAL POSITION".

12.2-3.7.1 PROCEDURE

The procedure for Undisturbed Sample Boring and Sampling must be the same as outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device must be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. The hydraulic down pressure must be read and recorded at 6 inch intervals during each sample drive. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.

12.2-3.7.2 SEALING

Both ends of the soil sample tube/liner obtained with a thin-walled sampler, must be cleaned out and/or disturbed soil removed to a minimum distance of 2 inches from the ends of the tube/liner. Any material removed must be placed in a sample jar and labeled in accordance with paragraph IDENTIFYING SAMPLES. The cleaned out ends of the sample liner tube must then be sealed with microcrystalline wax or acker plugs. A metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube must be inserted into the wax to a distance of 1/4-inch from the end of the soil sample. The wax plugs must be flush with the ends of the tube and a final seal consisting of a metal cap or tape must be placed over the ends of the tube.

12.2-3.8 TEST PIT EXCAVATION AND SAMPLING

12.2-3.8.1 EXCAVATION

The test pits must be excavated to depths and dimensions needed to permit soil classification and sampling of potential borrow material for physical property and compaction testing. Before excavating pits, the Contractor must thoroughly familiarize himself with work site, with all available subsurface data, particularly groundwater conditions, and with environmental mapping of the area. Regardless of the method of excavation employed, the pits must be excavated, dewatered and shored/lined in conformance with all applicable safety regulations.

12.2-3.9 BACKFILLING

12.2-3.9.1 DRILL HOLES

Unless otherwise noted in these specifications or directed by the Government, all drill holes must be backfilled and abandoned in accordance with all Federal, State, and local laws, regulations and ordinances. The Contractor must preserve all holes in good condition until final measurement and until the records and samples have been

accepted. As a minimum, all holes must be grouted from the bottom of the hole to within 1 foot of the ground surface using a grout mixture of six to eight gallons of water per sack (94 pounds) of portland cement and 5 pounds of powdered bentonite. All grout must be pumped through a tremie pipe that is inserted to the bottom of the boring to ensure that the grout fills the full extent of the hole. The remaining ungrouted top 1 foot of the hole must be backfilled with local soil and tamped. All backfilling operations must be performed in the presence of the Government and, if required by regulation, Federal, State, and local officials.

12.-3.9.2 TEST PITS

The Contractor must backfill all test pits with local soil compacted to original densities as directed by the Government.

12.2-3.10 RECORDS

The Contractor must keep accurate driller's logs and records of all work accomplished under this contract and must deliver complete, legible copies of these logs and records to the Government after a hole or test pit is completed. The records must be transmitted to the Government within the time frame defined in the Drilling and Invasive Program Plan. Format for logs and record form must be reviewed by the Government prior to performing any work. All such records must be recorded during the actual performance of the work and must be preserved in good condition and order by the Contractor until they are delivered and accepted. The Government has the right to examine and review all such records at any time prior to their delivery to him and must have the right to request changes to the record keeping procedure. The following information must be included on the logs or in the records for each hole and test pit:

- a. Hole or Test Pit identification number or designation and elevation of top of hole or test pit.
- b. Driller's name and Geologist's name.
- c. Make, size, and manufacturer's model designation of drilling and test-pit excavating equipment.
- d. Hole diameter.
- e. Dates and times when test-pit excavation or drilling operations were performed.
- f. Time required for drilling.
- g. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered. Include depth and estimated percent of drill fluid loss or lost circulation, measures taken to regain drill water circulation, and significant color changes in the drilling fluid return.
- h. Depths at which samples were recovered or attempts made to sample or core including top and bottom depth of each run. Record the depth and designation of each sample.
- i. Classification and description by depths of the materials penetrated using the Unified Soil Classification System (ASTM D2488). Include soil classification, Unified Soil Classification Symbol, secondary components and estimated percentages, color, plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and continuity,

- and grain size and angularity. This classification or description must be made immediately after the samples are retrieved.
- j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 6 inches of driven sample tubes. Include in information hammer weight and drop distance. Record information such as rod size, bit type, pump type, etc. Also include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use, and, if measured, mud viscosities and weight.
 - k. Depth of each change of stratum. If location of strata change is approximate, it must be so stated.
 - l. Percentage of sample recovered per run.
 - m. Depth at which groundwater is encountered initially and when stabilized.
 - n. Depth of bottom of hole.

12.3 TEMPORARY FACILITIES – TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

12.3-1 GENERAL

12.3-1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 241 (2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations

NFPA 70 (2023; ERTA 23-1 2023; ERTA 23-2 2023; ERTA 23-3 2023; ERTA 23-4 2023; ERTA 23-5 2023; ERTA 23-6 2023; ERTA 23-7 2023; ERTA 23-8; TIA 23-1; TIA 23-2; TIA 23-3; TIA 23-4; TIA 23-5; TIA 23-6; TIA 23-7; TIA 23-8; TIA 23-9; TIA 23-10; TIA 23-11; TIA 23-12; TIA 23-13; TIA 23-14; TIA 23-15; TIA 23-16; TIA 23-17) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2024) Safety and Occupational Health (SOH) Requirements

EP 310-1-6A (2019) Sign Standards Manual, VOL 1

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD (2015) Manual on Uniform Traffic Control Devices

12.3-1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 5-1.23 SUBMITTALS:

SD-01 Preconstruction Submittals

Construction Site Plan; G

Traffic Control Plan; G

Haul Road Plan; G

Pre-Construction Surveys of Roads; G

Project Signs; G

Temporary Wiring Diagram; G

Material Storage Silo Foundation Plan; G

SD-11 Closeout Submittals

Post-Construction Surveys of Roads;

12.3-1.3 CONSTRUCTION SITE PLAN

Prior to the start of work, submit a site plan showing the locations and dimensions of temporary facilities (including layouts and details, equipment and material storage and staging areas (onsite and offsite), soil stockpiles, batch plants, bentonite slurry mixing facilities, and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation. Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

12.3-2 PRODUCTS

12.3-2.1 TEMPORARY SIGNAGE

12.3-2.1.1 BULLETIN BOARD

Within two calendar days of mobilization on site and prior to the commencement of work activities, provide a clear weatherproof covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, Safety and Health Information as required by EM 385-1-1 Section 01 and other information approved by the Contracting Officer. Coordinate requirements herein with Section 7-1.02I of the Caltrans Standard Specifications.

12.3-2.1.2 PROJECT IDENTIFICATION SIGNS

The requirements for the project signs and content is located in EP 310-1-6A, Section 16. Exact locations are to be coordinated with and determined by the Contracting Officer. Erect signs within 15 days after receipt of the notice to proceed. Correct the data required by the safety sign daily, with light colored metallic or non-metallic numerals.

12.3-2.1.3 WARNING SIGNS

Post temporary signs, tags, and labels to give workers and the public adequate warning and caution of construction hazards according to the EM 385-1-1 Section 04.

Attach signs to the perimeter fencing every 150 feet warning the public.

presence of construction hazards. Signs must require unauthorized persons to keep out of the construction site. Correct the data required by safety signs daily.

12.3-2.2 TEMPORARY TRAFFIC CONTROL

12.3-2.2.1 HAUL ROADS

Construct access and haul roads necessary for proper prosecution of the work under this contract in accordance with EM 385-1-1 Section 04. Construct with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic are to be avoided. Submit haul road plan for approval. Provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, must be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and hauling roads are subject to approval by the Contracting Officer. Lighting must be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations.

Existing access roads, used by the Contractor, must be maintained at pre-construction condition or better throughout the contract period, including any portions of existing levees or levee ramps used for access or haul roads. The Contractor is responsible for the repair of any damage to roads caused by construction operations. In the pre-construction surveys of roads, the Contractor must survey profiles and cross-sections and make videos of the portions of existing roads, levees, and levee ramps that will be used by the Contractor as access or haul roads. The surveyed profiles and cross-sections and the video documentation must be submitted to the Government at least two weeks prior to use of the roads or levees. A second set of surveyed profiles and cross-sections and video documentation of the roads and levees used, post-construction surveys of roads, must be made and submitted to the Government within two weeks after completion of the construction and levee and road restoration work. The survey and video must demonstrate that the condition of the roads and levee segments after construction are at pre-construction condition or better, defined as follows:

- a. Road grade not lower than at pre-construction, per survey profile.
- b. Road width not lower than at pre-construction, per surveyed cross-sections.
- c. Road surfacing in equal or better condition than at pre-construction, per video documentation.

12.3-2.2.2 BARRICADES

Erect and maintain temporary barricades to limit public access to hazardous areas. Whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic barricades will be required. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

Provide fencing along the construction site and at all open excavations and tunnels to control access by unauthorized personnel. Safety fencing must be highly visible to be seen by pedestrians and vehicular traffic. Specific fencing requirements are as described herein. All fencing will meet the requirements of EM 385-1-1.

12.3-2.3.1 POLYETHYLENE MESH SAFETY FENCING

Temporary safety fencing must be a high visibility orange colored, high density polyethylene grid, a minimum of 48 inches high and maximum mesh size of 2 inches. Fencing must extend from the grade to a minimum of 48 inches above the grade and be tightly secured to T-posts spaced as necessary to maintain a rigid and taut fence. Fencing must remain rigid and taut with a minimum of 200 pounds of force exerted on it from any direction with less than 4 inches of deflection.

12.3-2.3.2 CHAIN LINK PANEL FENCING

Temporary panel fencing, where used, must be galvanized steel chain link panels 6 feet high. Multiple fencing panels may be linked together at the bases to form long spans as needed. Each panel base must be weighted down using sand bags or other suitable materials in order for the fencing to withstand anticipated winds while remaining upright. Fencing must remain rigid and taut with a minimum of 200 pounds of force exerted on it from any direction with less than 4 inches of deflection.

12.3-2.3.3 POST-DRIVEN CHAIN LINK FENCING

Temporary post-driven, where used, fencing must be galvanized chain link fencing 6 feet high supported by an tightly secured to galvanized steel posts driven below grade. Fence posts must be located on minimum 10 foot centers. Posts may be set in various surfaces such as sand, soil, asphalt or concrete as necessary. Chain link fencing must remain rigid and taut with a minimum of 200 pounds of force exerted on it from any direction with less than 4 inches of deflection. Fencing and posts must be completely removed at the completion of construction and any surfaces disturbed or damaged must be restored to its original condition. Underground utilities must be located and identified prior to setting fence posts. Fence must be equipped with a lockable gate. Gate must remain locked when construction personnel are not present.

12.3-2.4 TEMPORARY WIRING

Provide temporary wiring, where required, in accordance with EM 385-1-1 Section 11, NFPA 241 and NFPA 70. Include monthly inspection and testing of all equipment and apparatus. Submit the temporary wiring diagram for approval prior to energizing temporary power.

12.3-2.5 MATERIAL STORAGE SILO FOUNDATION PLAN

At least 30 days prior to mobilization or the start of any work, the Contractor must provide the Contracting officer engineering calculations and drawings, prepared by licensed structural engineer in the state of California, for foundation support system of material storage silos, accommodating applicable wind and seismic loads.

12.3-3 EXECUTION

Construction contract employees will park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Employee parking must not interfere with existing and established parking requirements of the government installation.

12.3-3.2 TEMPORARY BULLETIN BOARD

Locate the bulletin board at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer.

12.3-3.3 AVAILABLE AND USE OF UTILITY SERVICES

12.3-3.3.1 TEMPORARY UTILITIES

Provide temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, not create unsafe conditions, and not violate applicable codes and standards.

12.3-3.3.2 WATER

Temporary connections to existing fire hydrants and/or water mains may be utilized at the Contractor's option but must be coordinated by the Contractor with the local approving agency and must be disconnected at Project completion. Water will not be furnished by the Government. Water Usage shall be in accordance with Section 10-4 of the Caltrans Standard Specifications.

12.3-3.3.3 SANITATION

Provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer and periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into any municipal, district, or commercial sanitary sewer system. Any penalties or fines associated with improper discharge will be the responsibility of the Contractor. Coordinate with the Contracting Officer and follow station regulations and procedures when discharging into the station sanitary sewer system. Maintain these conveniences at all times. Include provisions for pest control and elimination of odors. Government toilet facilities will not be available to Contractor's personnel.

12.3-3.3.4 TELEPHONE

Make arrangements and pay all costs for telephone facilities desired.

12.3-3.3.5 FIRE PROTECTION

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials daily to minimize potential hazards.

12.3-3.4 TRAFFIC PROVISIONS

12.3-3.4.1 MAINTENANCE OF TRAFFIC

a. Conduct operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer.

Contracting Officer at least 15 calendar days prior to the proposed modification date, and provide a Traffic Control Plan detailing the proposed controls to traffic movement for approval. The plan must be in accordance with State and local regulations and the MUTCD, Part VI. Make all notifications and obtain any permits required for modification to traffic movements. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

b. Conduct work so as to minimize obstruction of traffic, and maintain traffic on at least half of the roadway width at all times. Obtain approval from the Contracting Officer prior to starting any activity that will obstruct traffic.

c. Provide, erect, and maintain, at contractors expense, lights, barriers, signals, passageways, detours, and other items, that may be required by the Life Safety Signage, overhead protection authority having jurisdiction.

12.3-3.4.2 PROTECTION OF TRAFFIC

Maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment the work, and the erection and maintenance of adequate warning, danger, and direction signs, will be as required by the State and local authorities having jurisdiction. Protect the traveling public from damage to person and property. Minimize the interference with public traffic on roads selected for hauling material to and from the site. Investigate the adequacy of existing roads and their allowable load limit. Contractor is responsible for the repair of any damage to roads caused by construction operations.

12.3-3.4.3 DUST CONTROL

Dust control methods and procedures must be approved by the Contracting Officer. Coordinate dust control methods with Section 10-5 of the Caltrans Standard Specifications.

12.3-3.5 CONTRACTOR'S TEMPORARY FACILITIES

12.3-3.5.1 ADMINISTRATIVE FIELD OFFICE

The contractor must furnish and maintain a trailer-type mobile office acceptable for its staff and a separate office(s) for the Government. The trailers must be located within the construction limits at a location suitable to the Government. Government trailers may be located within the Contractor's compound. The trailers must be securely anchored to the ground at all four corners to guard against movement during high winds. A mail slot in the door or a lockable mail box mounted on the surface of the trailer must be provided. At completion of the Project, the trailers will become the property of the Contractor and must be removed from the site. Doors must be lockable and keys must be provided to the Government. All utilities must be connected and disconnected in accordance with local codes and to the satisfaction of the Government.

The furniture, equipment, and incidentals listed below must be provided, set up and maintained by the Contractor for the Government's office. Furniture, equipment, utilities and incidentals must remain the property of the Contractor and must be removed from the site after the Project is complete. Government trailers must conform to the following requirements:

- a. Provide two office trailers, minimum 1440 square feet each, or one office trailer with a minimum 2160 square feet. Trailers must have a minimum of six offices total and a common space. Condition of trailer must be clean and acceptable to the Government. Provide locks and eight sets of keys for the Government. Trailers must be ADA compliant and have ramp access. One office must be keyed as determined by the Government.
- b. Provide reliable power for office lighting and equipment operation.
- c. Provide heating and cooling for trailer. Equipment must maintain an ambient air temperature of 73 degrees Fahrenheit.
- d. Provide eight desks (30" x 60" min.) with drawers, eight office chairs, and waste baskets.
- e. Provide vertical filing plan racks for four sets of 11 x 17 inch plans and two sets of 24 x 36 inch plans.
- f. Provide twenty-five stackable or folding chairs, four 48 x 96 inch tables, and four 30 x 96 inch tables. The 48" x 96" tables may be substituted for one conference table of similar size to the 4 tables (72" x 192").
- g. Provide six bookshelves, 4 feet x 6 feet. Provide six vertical four-drawer legal size file cabinets. Provide one 72"W x 72"H x 18"D and one 36"W x 72"H x 18"D lockable storage cabinet. Each cabinet must have a minimum of four removable and adjustable shelves. The cabinets must be keyed after they are installed. A minimum of two keys must be provided for each cabinet.
- h. Provide two 5-lb, non-toxic, dry-chemical fire extinguishers meeting Underwriters' Laboratories, Inc. requirements with each trailer.
- i. Provide and maintain flush-type sanitary facilities within each trailer and sanitation disposal. Two restrooms will be furnished in one trailer. One restroom will be furnished in the remaining trailer. Water service must be potable water.
- j. Provide maintenance of all facilities and waste disposal and keep offices clean and all equipment in good working condition.
- k. Provide one bottle water cooler with chilled and hot drinking water and cups for each trailer. Contractor must supply bottled water and cups as required for the duration of the Project.

- l. Provide one refrigerator approximately 25 cubic feet. Provide one cubic foot microwave.
- m. Provide adequate security of all facilities and furnished equipment. Lighting to illuminate the trailers and parking facilities must be provided. Lighting must be dusk to dawn with the ability to adjust the light position and illumination.
- n. Provide one copy/printer machine with reduction, enlargement, and auto-detect feed. Copy machine must be Sharp MX-3140N or better, capable of copying up to 11 x 17 inch pages. Contractor must provide copier servicing as necessary. The copier must be capable of networking to computers for printing.
- o. Provide six 4' x 6' dry-erase boards, markers, and erasers.
- p. Provide telephone service capable of four separate phone lines. Phone lines and Internet capabilities must be routed to each office and the multiple common areas, 6 desk type phones, 2 conference type phones with remote microphones.
- q. Provide all necessary utilities for equipment and trailer.
- r. The Government will provide the personal computers. The contractor must provide a high speed Internet service (cable, DSL, satellite, etc.) for the Government's computers.
- s. Network and Connectivity - Office trailer data network with server and wired connections to the offices, the copier/scanner and 3 connections to the main part of the office trailer. Office trailer Wi-Fi router capable of being accessed from all parts of the office trailer.
- t. Trailers must be cleaned weekly.
- u. Parking - Suitable all weather parking for 20 vehicles (1 ADA parking stall) must be provided in the immediate vicinity of the trailers. Surface must meet SWPPP requirements.
- v. Grass & weeds must be cut a minimum of once per month.
- w. Temporary 6 foot high chain link fence with gate around trailers and storage areas.

The Contractor may, at its option, furnish and maintain a building-type mobile office or a permanent building acceptable to the Government and providing, as a minimum, the facilities specified above.

12.3-3.5.2 STORAGE AREA

Construct a temporary 6 foot high chain link fence around trailers and materials. Include plastic strip inserts, colored brown, so that visibility through the fence is

obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Do not place or store trailers, materials, or equipment outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the installation boundaries. Trailers, equipment, or materials must not be open to public view with the exception of those items which are in support of ongoing work on any given day. Do not stockpile materials outside the fence in preparation for the next day's work. Park mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment within the fenced area at the end of each work day.

12.3-3.5.2.1 MAINTENANCE OF STORAGE AREA

Keep fencing in a state of good repair and proper alignment. Grassed or unpaved areas, which are not established roadways, and will be traversed with construction equipment or other vehicles, will be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways, should the Contractor elect to traverse them with construction equipment or other vehicles. Mow and maintain grass located within the boundaries of the construction site for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers will be edged or trimmed neatly.

12.3-3.5.2.2 RESERVED SPACE FOR GOVERNMENT USE

The Contractor must reserve a 10,000 square foot area, with one side being not shorter than 75 linear feet, of the Staging Area to be used exclusively by the Government or entities appointed by the Government. This reserved area must be guaranteed free access at all times and be located as close as reasonably possible to the staging area access point.

12.3-3.5.3 SECURITY PROVISIONS

Provide adequate outside security lighting at the temporary facilities. The Contractor will be responsible for the security of its own equipment.

12.3-3.5.3.1 SUSPICIOUS ACTIVITY REPORTING TRAINING (iWATCH)

The contractor and all associated sub-contractors must receive a brief training on the local suspicious activity reporting program (iWATCH). This training will be used to inform employees of the types of behavior to watch for and instruct employees to report suspicious activity to the Contracting Officer, security representative, or appropriate law enforcement. This training must be completed within 30 calendar days of contract award and within 30 calendar days of new employees commencing performance with the results reported to the Contracting Officer not later than 5 calendar days after the completion of the training.

12.3-3.5.4 WEATHER PROTECTION OF TEMPORARY FACILITIES AND STORED MATERIALS

Take necessary precautions to ensure that roof openings and other critical openings in

the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

12.3-3.5.4.1 BUILDING AND SITE STORM PROTECTION

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions must include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

12.3-3.6 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, furnish and erect temporary project safety fencing at the work site. Maintain the safety fencing during the life of the contract and, upon completion and acceptance of the work, remove from the work site.

12.3-3.7 CLEANUP

Remove construction debris, waste materials, packaging material and the like from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways must be cleaned away. Store any salvageable materials resulting from demolition activities within the fenced area described above or at the supplemental storage area. Neatly stack stored materials not in trailers, whether new or salvaged.

12.3-3.8 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and any other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used during the performance of the contract to the original or better condition. Remove gravel used to traverse grassed areas and restore the area to its original condition, including top soil and seeding as necessary.

12.4 EARTHWORK

12.4-1 GENERAL

These Special Provisions to Section 19 of the Caltrans Standard Specifications documents and shall govern the use of Levee Fill material as identified in the DMM cutoff wall construction and levee reconstruction plans, drawings L-1 through L-9. Fill materials required for the construction of the bridge approach, access ramps, and other ancillary earthwork features beyond the extents of fill material identified as Levee Fill shall be constructed in accordance with the Caltrans Standard Specification Section 19, Earthwork.

12.4-1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM D1140 (2017) Standard Test Methods for Determining the Amount of Material Finer than 75- μm (No. 200) Sieve in Soils by Washing

ASTM D1556 (2024) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D2216 (2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2487 (2025) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D2974 (2025) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

ASTM D3740 (2023) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D4318 (2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4643 (2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating

ASTM D6913 (2021) Particle-Size Distribution of Soils using Sieve Analysis

ASTM D6938 (2023) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D698 (2021) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2024) Safety and Occupational Health (SOH) Requirements

ER 1110-1-261 (1999) Quality Assurance of Laboratory Testing Procedures

EM 1110-2-1911 (1995) Construction Control for Earth and Rock-Fill Dams

EP 1110-2-18 (2019) Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846.3-3 (1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical

12.4-1.2 DEFINITIONS

12.4-1.2.1 SUITABLE MATERIALS

Suitable materials must consist of materials classified in accordance with ASTM D2487 as CL, CL-ML, ML, SC, SM, GP-GC, GW-GC, SP, SW, SP-SM, SW-SM, SP-SC, and SW-SC meeting the additional requirements of paragraph 12.4-2.2, Types of Fill Materials and paragraph 12.4-2.3, Requirements for Offsite Soils provided by the Engineer, and free from debris and organic material as defined herein.

12.4-1.2.2 UNSUITABLE MATERIALS

Unsuitable materials include all other materials that are not defined as suitable materials in paragraph 12.4-1.2.1 herein. Materials are not classified as unsuitable based solely on moisture content. Unsuitable materials must be disposed of in accordance with Section 17-2.03D Disposal of Materials.

Soils containing visible concentrations of organics, or classified as organic clay or organic silt (OH or OL) in accordance with ASTM D2487 are unsuitable.

12.4-1.2.3 DEBRIS

Material containing roots greater than 1/2-inch in diameter of any length, roots greater than 6-inches in length, rubble, trash, or other deleterious or perishable items are classified as debris.

12.4-1.2.4 FILL MATERIAL

The terms "fill", "backfill", or "embankment" as used in these specifications are defined as the earth fill portions of the levee embankment structure, ramps, or other fills related to the levee.

12.4-1.2.5 STRUCTURAL BACKFILL

Earthen fill to be placed within 4-feet of completed or partially completed structures.

12.4-1.2.6 DEGREE OF COMPACTION

Degree of compaction must be expressed as a percentage of the maximum dry density obtained by the wet preparation method test procedure presented in ASTM D698 abbreviated as a percent of laboratory maximum dry density.

12.4-1.2.7 OVER-EXCAVATION

Excavation beyond the limits shown on the Plans not directed by Contracting Officer.

12.4-1.2.8 CONTROLLED LEVEE DEGRADE

Controlled levee degrade is the process of using a piece of equipment with a flat blade to remove levee fill in four (4) to six (6) inch layers to provide Tribal monitors and the Contractor's archaeological monitor an opportunity to more thoroughly observe the levee degrade process. Excavation must be performed in a manner as to not disturb the freshly exposed subterrain, including driving over, prior to the Monitors' inspection. See Caltrans Standard specification Section 14 Environmental Stewardship, for additional information.

12.4-1.3 QUALIFICATIONS

The earthwork contractor performing levee construction and reconstruction must have experience in projects of similar size and scope completed in the last five (5) years. The project experience must have been performed by the entity proposing to perform the work as defined below. An individual's experience from former companies qualifies as 201101-23
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experience provided that the individual is the Contractor's designated Project Manager or Site Superintendent. Qualifying experience in levee construction and reconstruction must consist of the following: "Satisfactorily performed the work and completed the construction of at least three levee projects including either (1) levee construction, or (2) levee degrading and reconstruction for the purpose of cutoff wall construction". The projects need to include a minimum levee embankment quantity of 75,000 cubic yards.

Refer to the proposal forms for additional information.

12.4-1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following must be submitted in accordance with Section 5-1.23 SUBMITTALS:

SD-01 Preconstruction Submittals

Excavation and Embankment Operations Plan; G

Pre-Construction Condition of Levee Crown Roadway Gravel, Paving, and Levee Slope Area; G

Flood Contingency Response Plan; G,

Survey Data; G

Equipment Data

Sheeting and Shoring Plan; G

Geotechnical Engineer; G

Slide and Foundation Failure Repair Plan; G,

Working Surface Modification Plan; G,

SD-03 Product Data

Embankment and Backfill Materials including Surfacing Aggregates; G,

SD-06 Test Reports

Borrow Site Lab Test Results, G,

SD-07 Certificates

Testing Laboratory Certificates meeting the requirements of ASTM D3740 and ER 1110-1-261; G

SD-09 Manufacturer's Field Reports

Quality Control Testing

Test Data Summaries; G,

SD-11 Closeout Submittals

Construction Verification Survey Report; G

12.4-1.4.1 EXCAVATION AND EMBANKMENT OPERATIONS PLAN

Submit a written excavation plan a minimum of twenty (20) days prior to the start of excavation. 283199 - 23

beginning of any excavation. Review of the detailed plan is obtained from the Contracting Officer prior to starting the work. If necessary, the plan must be modified as required to meet field conditions, and the modifications must be reviewed by the Contracting Officer prior to use. As a minimum, the plan must contain the following:

- a. Proposed methods for preventing interference with, or damage to, existing underground or overhead utility lines, trees designated to remain, and other man-made facilities or natural features designated to remain within or adjacent to the construction right-of-way.
- b. The proposed methods for controlling surface and ground water in the required excavations.
- c. Excavation plan showing locations of temporary stockpiles, stockpile heights, slopes, limits, and drainage around the stockpile areas. Describe blending areas and methods if blending of materials is planned.
- d. A complete listing of equipment used for excavation and transport of the excavated material.
- e. The Contractor's proposed sequence of work for excavating with plan and cross sectional views showing starting and final work locations and clearing, grubbing and stripping limits.
- f. Site plans detailing the Contractor's proposed locations and construction of all haul roads and ramps within the construction limit, road pattern and plan for implementing dust control measures.
- g. Earth material distribution and stockpile plan that describes where material will be obtained, placed, stockpiled and blended for usage or for temporary disposal.
- h. Contractor's proposed sequence of construction for embankment and backfill items, and methods and types of equipment to be utilized for all embankment and backfill operations, including transporting, placing, and compaction.
- i. Names and addresses of the commercial testing labs which will perform the soil testing and inspection. Government validated labs are required per <https://mtc.erd.c.dren.mil/>.
- j. Describe how all required soils testing will be performed and reported.

12.4-1.4.2 PRE-CONSTRUCTION CONDITION OF LEVEE CROWN ROADWAY GRAVEL, PAVING, AND LEVEE SLOPE AREA

Documentation and video tape of pre-construction condition of levee crown roadway showing adequate detail and levee slope areas showing existing conditions per these Contract Documents.

12.4-1.4.3 FLOOD CONTINGENCY RESPONSE PLAN

In the event the water surface elevation of the Sacramento River is forecasted by the State-Federal Flood Forecast Center to increase significantly for any reason, the Agency reserves the right to require the Contractor to stop excavation and to begin continuous operations to complete all partially completed section(s) of the levee embankment, the slurry cutoff wall including capping layers, and berms. The Contractor shall not begin activities that reduce the level of flood protection, as determined by the Agency, prior to April 15. The Contractor shall reconstruct the levee and complete all levee improvements planned for the construction season by November 1.

In the event high water is forecasted, the Contractor shall restore the levee line and grade to provide a minimum of three feet of freeboard above the maximum forecast river stage, and take precautions to secure and protect the Work and the site against damage during passage of the flood. In addition Contractor shall remove personnel, materials, equipment, and temporary facilities from within the floodway at least 24 hours before the water level is predicted to reach the work areas or waterside staging areas.

At least 15 days prior to any levee excavation, the Contractor shall submit a Flood Contingency Response Plan outlining the contingency operations in the event that river elevations above "Construction Flood Stage" (defined as the river stage of Elevation +27.5, NAVD 88) as measured at the I Street gauge unless otherwise defined by the Agency are forecasted.

The Flood Contingency Plan shall include a schedule with clearly defined interim construction stages and completion dates, and a flood emergency contingency plan to be implemented by the Contractor if a high water event occurs during the non-flood season or prior to completion of levee reconstruction. Specific items to be addressed shall include but not be limited to the following:

- a. Schedule for construction activities that will occur in the floodplain and construction activities that will result in the temporary reduction of the flood protection, such as the temporary lowering of the levee crest and deep excavation activity along the levee toe of the levee.
- b. The higher possibility of flooding through June along the Sacramento River.
- c. The length of levee to be degraded at any one time.
- d. The proposed measures to protect the landside areas which have a reduced level of protection due to construction activities.
- e. The plan shall include continuous monitoring of the river stage at the project location, monitoring of the guidance plot for the I Street gage location on the California Data Exchange Center website, and , determining the river stage in coordination with USACE at which the plan will be activated, material and equipment to be used in performance of the contingency plan, and the existing location, type and quantity of the stockpiled emergency material.
- f. A list of equipment and materials that will be located within the floodway.
- g. A description of how precipitation and river level forecasts and actual levels will be monitored at the site, including the names of the persons responsible for monitoring the river levels and forecasts and how they will

- communicate with construction staff and the Agency.
- h. The measures to be undertaken before, during and after a significant rainfall or flood event, including information on how equipment or stockpiles within the floodway will be removed or secured if their removal is impractical.
 - i. Identification of contingency actions, procedures and specific time factors for:
 - i. Flood warning protocols and procedures
 - ii. Communication channels and command structure for flood preparation and fighting activities
 - iii. Flood fighting courses of action, including but not limited to restoring the levee to the line and grade needed to contain the forecast flood with a freeboard of three feet or greater.
 - iv. Securing the site during floods.
 - j. In the event of a flood emergency requiring action by the jurisdictional flood control agencies (City of Sacramento, DWR Maintenance Area 9, City of West Sacramento, DWR Maintenance Area 4, USACE, CVFPB, California Governor's Office of Emergency Services) prior to completion of the work, the Agency shall have the right to suspend the work until the emergency is resolved and to take over the project site to conduct flood protection and/or fighting activities as may be necessary.

12.4-1.4.4 SURVEY DATA

Copies of survey data in the form of cross sections of the levee prior to construction must be submitted. The Contractor must submit written certification that the data is accurate and surveying was performed by a surveyor authorized to practice land surveying in the State of California. Submit all data within 24 hours of performing field surveys per these Contract Documents.

12.4-1.4.5 EQUIPMENT DATA

Equipment data used for hauling, fill placement, compaction, and sprinkling equipment must be submitted and include weights, size, and contact pressures.

12.4-1.4.6 SHEETING AND SHORING PLAN

Submit drawings and calculations, certified by a registered civil engineer authorized to practice in the State of California, describing the methods for shoring and sheeting of excavations if required. Drawings must include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations must include data and references used.

12.4-1.4.7 GEOTECHNICAL ENGINEER

The Contractor must provide a Professional Geotechnical Engineer licensed in the State of California, with a minimum of five years of experience on similar projects, to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions.

The Engineering/Geotechnical Engineer must update the excavation, sheeting and dewatering

plans as construction progresses to reflect changing conditions and must submit an updated plan as necessary. A written report must be submitted, at least monthly, informing the Government and Construction Manager of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer must be available to meet with the Government and Construction Manager at any time throughout the contract duration.

12.4-1.4.8 SLIDE AND FOUNDATION FAILURE REPAIR PLAN

A plan for any slide or foundation failure repairs must be submitted in accordance with Paragraph "Slides and Foundation Failures."

12.4-1.4.9 WORKING SURFACE MODIFICATION PLAN

A plan for any proposed modification to the working surface elevations must be submitted in accordance with Paragraph "Levee Crown Degrade."

12.4-1.4.10 EMBANKMENT AND BACKFILL MATERIALS INCLUDING SUBSURFACING AGGREGATES

At least 15 days prior to delivery of any offsite material to the site of the work, the Contractor must submit soil classification test results, moisture-density curves, gradation curves, and laboratory results of the required tests of the proposed borrow material for review by the Government. A family of moisture-density curves must be developed onto one moisture-density graph. Each curve is to be given a number and identify the maximum dry density and optimum moisture content point and values. The family of curves is to be updated and submitted weekly with the latest test information.

12.4-1.4.11 BORROW SITE LAB TEST RESULTS

The Contractor must submit all quality control test results. Testing laboratories must meet the requirement of ASTM D3740. Supervision of tests and report preparation must be by a professional civil engineer licensed in the state of California. All reports must bear said professional engineer's signature and stamp. Distribution of the copies to the Contracting Officer must be a maximum of 24 hours after completion of the test and at least 48 hours prior to placement of the fill.

12.4-1.4.12 TESTING LABORATORY CERTIFICATES

Submit Testing Laboratory Certificates meeting the requirements of ASTM D3740 and ER 1110-1-261

12.4-1.4.13 QUALITY CONTROL TESTING

The Contractor must submit all quality control test results. Testing laboratories must meet the requirement of ASTM D3740 and ER 1110-1-261. Supervision of tests and report preparation must be by a professional civil or geotechnical engineer licensed in the State of California. All reports must bear said professional engineer's signature and stamp. Distribution of the copies to the Government must be within 24 hours

The Engineering Enterprise or initiating the test, except for test requirements that exceed 24 hours.

For tests exceeding 24 hours, distribution must be within 24 hours after completion of the test.

All test reports must be provided electronically and hard copy. Submit electronic copies in post-script document format (PDF). Summary tables must be provided in electronic spreadsheet files format (Microsoft Excel or equivalent tabular, delineated format). Scanned PDF documents are not acceptable for submittals; only PDF documents generated directly from software (e.g. database, spreadsheet or other laboratory software programs, etc) are acceptable.

12.4-1.4.14 TEST DATA SUMMARIES

Summaries comparing test results with specified requirements must be provided in electronic format and hard copy, demonstrate contract compliance, and be submitted with all requests for progress payments.

12.4-1.4.15 CONSTRUCTION VERIFICATION SURVEY REPORT

The Contractor must complete post-construction verification surveys and submit a "Construction Verification Survey Report" which will include the description of equipment used, a description of methodology used, copies of the field notes, and the final data submitted. This report must contain the certificate below, and be stamped and signed by the Professional Land Surveyor (or Civil Engineer, if legally allowed to practice surveying in the State of California) responsible for the survey work performed.

Surveyor's Levee Elevation Certificate:

I, the undersigned, do hereby state that I am licensed to perform surveying in the State of California, and I do hereby certify that the pre-construction and post-construction surveys for measuring the levee(s) were performed by me or by qualified staff under my supervision. I further certify that the technologies and methods used for these surveys are in compliance with the specifications for this project and that the data from said surveys comply with tolerances specified for this project.	
_____ Surveyor's Name	_____ Date
CA PLS/CE No.: _____	

12.4-1.5 GENERAL CONDITIONS

12.4-1.5.1 LINES AND GRADES

The embankments and backfills must be constructed to the lines, grades, and cross sections indicated on the Plans, unless otherwise directed by the Contracting Officer. The Contracting Officer reserves the right to increase or decrease the foundation depths, widths and embankment slopes or to make such other changes in the embankment or backfill sections as may be deemed necessary to produce a safe

structure. Changes in quantities resulting from such revisions will not constitute justification for change in contract unit prices, except as provided for in the Contract Documents.

12.4-1.5.2 CONDUCT OF THE WORK

The Contractor must maintain and protect the embankment and backfill in a satisfactory condition at all times until final completion and acceptance of all work under the Contract. If hauling equipment causes horizontal shear planes or slicken slides, rutting, quaking, heaving, cracking, or excessive deformation of the embankment or backfill, the Contractor must limit the type, load, or travel speed of the hauling equipment on the embankment or backfill. The Contractor may be required to remove, at his own expense, any embankment material placed outside of prescribed slope lines. Any approved embankment or backfill material that is lost in transit or rendered unsuitable after being placed in the embankment or backfill and before final acceptance of the work must be replaced by the Contractor in a satisfactory manner and no additional payment will be made. The Contractor must excavate and remove from the embankment or backfill any material that is unsatisfactory and must also dispose of such material and refill the excavated area as directed, all at no cost to the Government.

12.4-1.5.3 HAUL ROADS

Haul roads and ramps must be located and/or constructed within the construction limits shown on the Plans. Prior to the commencement of construction the Contractor must submit for review a site plan detailing the location of all haul roads and ramps within the construction limits. Haul roads and ramps must be constructed to maintain the intended traffic, be free draining, and be maintained in good condition throughout the contract period. Contractor will be responsible for maintenance of levee haul roads during construction if portions of existing levee are used. Haul roads and ramps that cross any creek or drainage channel must be constructed and maintained by the Contractor so as to not flood either upstream areas by restricting stream flows or flood downstream areas by the release of any stored water in the event that the crossing fails for any cause. Unless otherwise directed by the Government, haul roads and ramps constructed during the contract duration must be removed after work is completed and the impacted area restored to its preconstruction conditions. All haul roads within the right-of-way that will remain as public thoroughfares after construction must be cleaned daily and maintained in the preconstruction condition. All costs associated with these haul roads and ramps must be considered as a subsidiary obligation of the Contractor.

12.4-1.5.4 SLIDES AND FOUNDATION FAILURES

The Contractor must repair any sliding that occurs in any part of the embankment and backfills prescribed in this section prior to final acceptance of the work. When the slide is caused through the fault of the Contractor, the repair must be made at no cost to the Government. The Contractor must submit a plan detailing how the repair will be completed. The plan must be reviewed by the Government prior to the start of repair work. When the slide is not the fault of the Contractor, an extension of the unit prices for excavation and embankment must be made to cover the cost of the repairs.

12.4-1.5.5 DRAINAGE REQUIREMENTS

The Contractor must not block or restrict the flow in a natural drain, existing culvert, ditch, or channel without first notifying the Government and having the Government review the proposed plan. After the Government has made this review, the Government will permit the Contractor to proceed based on satisfactory performance of the Contractor's plan. Any non-performance issues will be the sole responsibility of the Contractor. The Contractor must monitor the channel flow and provide sufficient free discharge areas so that conditions are not worsened upstream or downstream by possible floods during construction. Surface water must be directed away from excavations and construction sites so as to prevent pending erosion and undermining of foundations. Diversion ditches, dikes, and grading must be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces must be protected to prevent pending erosion and sloughing. Excavation must be performed so that the site and the area immediately surrounding the site and affecting operations at the site must be continually and effectively drained. If private property is to be used for drainage, the Contractor must submit written evidence that the right has been obtained from the property owner for drainage on his property.

12.4-1.5.6 UTILITIES

Movement of construction machinery and equipment over pipes and utilities during construction will be at the Contractor's risk. Utility lines damaged during construction must be immediately reported to the Contracting Officer. Repairs must be coordinated with the utility owners and must be at no cost to the Government.

12.4-1.5.7 PROTECTION OF EXISTING MAN-MADE FACILITIES AND NATURAL FEATURES

Embankment excavation must be conducted in such a manner as to avoid damage to trees left standing and trees outside the excavation areas, existing buildings, man-made facilities and natural features, with due regard to the safety of employees and others.

12.4-1.5.8 ACCESS TO BORROW SOURCES AND STOCKPILES

Contractor must allow the Government to access, inspect, and sample all borrow sources and stockpiles at least two weeks before beginning to haul materials to the project site and at any time during borrow operations.

12.4-1.5.9 TREE REMOVAL

Tree removal shall include consist of removing the canopy, tree trunk and roots per Section 12.4-3.3.5.

12.4-1.5.10 FLOOD SEASON CONSTRUCTION RESTRICTIONS

Levee degrade, features of project work that are to be performed within project levee easements, and levee reconstruction, must be performed during the non-flood season defined as April 15th to November 1st. Construction during the flood season will not be permitted.

12.4-2 PRODUCTS

12.4-2.1 MATERIALS

12.4-2.1.1 FILL MATERIALS

Project fills must be constructed of suitable earth materials as defined in 12.4-1.2 DEFINITIONS and specified in 12.4-2.2 TYPES OF FILL MATERIALS, and obtained from the borrow source(s) identified by the Contractor and approved by the Government. Materials must be tested for suitability prior to placement.

Embankment materials must have no roots greater than ½-inch in diameter of any length, and no roots greater than 6-inches in length, limbs or wood fragments.

Materials containing roots, debris, rubble, other deleterious items, perishable material, and trash must not be used in the fill. Excess material generated by the soil-bentonite cutoff wall construction operations may be used for Levee Embankment Fill Soil Type 2 if it meets the requirements of the Specifications but may not be used for Levee Embankment Fill Soil Type 1. Soil laced with cement from DMM wall cuttings may not be used in any part of levee embankment construction. Material containing oversized particles must be screened at the borrow source to meet the gradation requirements specified below. Material not meeting the specified requirements must be hauled off site and disposed of in a legal manner. Materials must be blended as needed to obtain a blended material suitable for construction meeting the fill requirements outlined in these Specifications. Bentonite affected soils may only be allowed in Type 2 fill with adequate drying/curing, blending and processing so as to meet the specified requirements for Type 2 materials and respective moisture contents. Soil classification tests must be completed for all material in accordance with ASTM D2487.

Soils classified as organic clay or organic silt (OH or OL) are unsuitable and cannot be blended for use in the levee embankment. These materials must be hauled off-site. Debris as defined in paragraph 12.4-1.2 DEFINITIONS must be disposed of off-site.

Blended material must not be used without approval from the Contracting Officer. Materials must be blended at the borrow site or approved stockpile area. Blending of materials is not allowed on the fill.

12.4-2.2 TYPES OF FILL MATERIALS

12.4-2.2.1 LEVEE EMBANKMENT FILL (SOIL TYPE 1) MATERIAL REQUIREMENTS

Soil Type 1 fill material must be suitable material obtained from approved offsite borrow sources, must consist of low to medium plasticity soils classified in accordance with ASTM D2487 as lean clay (CL), clayey sand (SC), silty sand (SM), or silt (ML), must have no visible concentrations of organic content and must meet the following requirements:

GRADATION		ASTM TEST PROCEDURE
Sieve Size	Percent Passing	
2-inch	100	ASTM D6913
No. 4	>85	ASTM D6913
No. 200	>30 <80	ASTM D1140
Liquid Limit: <46		ASTM D4318 (wet preparation method)
Plasticity Index: 8 to 30		ASTM D4318 (wet preparation method)

Additional testing for blended material will be required in accordance with Field Quality Control. Bentonite spoils from SB cutoff wall construction may not be blended into Soil Type 1 fill material even if the resulting blended material meets the requirements specified in this paragraph.

12.4-2.2.2 LEVEE EMBANKMENT FILL (SOIL TYPE 2) MATERIAL REQUIREMENTS

Levee Embankment Fill (Soil Type 2) must be suitable material obtained from levee degrade or approved offsite borrow source, and must meet the requirements tabulated below. Levee Embankment Fill (Soil Type 2) must have no visible concentrations of organic content.

GRADATION		ASTM TEST PROCEDURE
Sieve Size	Percent Passing	
2-inch	100	ASTM D6913
No. 200	7-30	ASTM D1140
Liquid Limit: <46		ASTM D4318 (wet preparation method)
Plasticity Index: <20		ASTM D4318 (wet preparation method)

Excess material produced by soil-bentonite cutoff wall excavation and construction can be used as levee embankment fill Type 2 if, with adequate blending and processing, fill meets specified requirements for Type 2 materials and respective moisture contents. Additional testing for blended material will be required in accordance with Field Quality Control.

12.4-2.2.3 RANDOM FILL

Random fill may be obtained from project excavations or approved offsite borrow sources and must consist of suitable material with a maximum particle size less than 2 inches in smallest dimension. Random fill must not include debris, visible concentrations of organics, cement, aggregate base, asphalt concrete, or stripped material.

12.4-2.2.4 TEMPORARY SOIL CAP

Temporary Soil Cap placed over completed slurry cutoff walls must be uncompacted Levee Embankment Fill (Soil Type 1).

12.4-2.2.5 STRUCTURAL BACKFILL

Structural backfill placed within the levee prism must be compacted Levee Embankment Fill (Soil Type 1). Structural backfill placed outside the levee prism must be compacted Levee Embankment Fill (Soil Type 2).

Blended material cannot be used without approval from the Contracting Officer. Materials must be blended at the borrow site or approved stockpile area. Blending of materials is not allowed on the fill. Screening of oversized material, if necessary to meet the specified gradation criteria, is to be performed at borrow source prior to importing onsite. Additional testing for blended material will be required in accordance with Field Quality Control.

12.4-2.3 REQUIREMENTS FOR OFFSITE SOILS

12.4-2.3.1 GENERAL CHEMICAL TESTING REQUIREMENTS

Offsite soils must be chemically tested prior to being considered as fill material onsite. Submit a work plan to the contracting officer for approval in accordance with Section 12.4-2.3.1.1 Offsite Borrow Site Soil Sampling Work Plan. Conduct the sampling activities according to the approved plan. The sample results must then be compared against the "Imported Fill Chemical Screening Limits" values included with this specification.

The Contractor is responsible for ensuring that the testing is performed and the results are submitted as part of the Offsite Borrow Area Chemical Suitability Report. The Offsite Borrow Site Chemical Suitability Report must meet the requirements outlined in Section 12.4-2.3.6 Offsite Borrow Site Chemical Suitability Certification Report. Material from an offsite borrow area can be brought onsite only after the contracting officer has provided approval confirming that the material meets the soil screening criteria.

12.4-2.3.1.1 OFFSITE BORROW SITE SOIL SAMPLING WORK PLAN

Within 14 days after the Contract Award and at least 30 days prior to the sampling activities at any offsite borrow site, a plan including, but not limited to, the following: number of samples, sample methods and analysis, sample procedures, laboratory who is performing the analysis, and quality control and quality assurances, is to be

The Engineering Division requires the Contracting Officer for approval. The Contractor must not collect any

samples at the offsite borrow site before government's approval. The work plan must be certified by California-licensed professional engineer or geologist.

12.4-2.3.2 SAMPLE COLLECTION

The soil samples must be collected from evenly distributed locations across the offsite borrow site so that the analytical results are as close as possible to being representative of each overall site. Samples will be preserved, transported and analyzed in accordance with EPA SW-846.3-3. The discrete soil samples from the offsite borrow site will normally be composited into one sample by the analytical laboratory for analyses; individual site conditions, however, may also dictate that the discrete samples be analyzed separately. Sample collection locations should be noted in the field, and recorded in latitude-longitude and/or California State Plane coordinate formats.

12.4-2.3.3 CHEMICAL TESTING

All offsite borrow site soil must undergo a solids analysis for undesirable constituents. The soil constituent concentrations will then be compared against the Chemical Screening Limits presented in section 12.4-2.3.4. In the event any of those limits are exceeded, perform testing to determine the potential soluble concentration of the constituent(s). All analysis must be performed at a facility that is ELAP/NELAP certified for the methods used.

12.4-2.3.3.1 SOLUBLE CONSTITUENT TESTING

Soluble constituent testing will only be required in the event that the constituent concentration was above the Maximum Concentration for Solids Analysis value provided in the Chemical Screening Limits presented in section 12.4-2.3.4. The soluble analyses must be conducted using the Waste Extraction Test procedure (WET) to generate an extractant that can be tested. Analysis on the extractant must include only the constituents listed as having a Soluble Threshold Limit Concentration (STLC) on the Chemical Screening Limits presented in section 12.4-2.3.4.

12.4-2.3.4 POTENTIAL CONTAMINANTS OF CONCERN AND SCREENING CRITERIA

Due to the growing concern over the suitability of borrow material increased testing requirements have been initiated. The offsite borrow site soil must be tested for total concentrations of screening constituents. A table of constituents, "Imported Fill Chemical Screening Limits," that are to be included in the analysis are presented below. The tested offsite borrow site soil is to be compared against the Maximum Concentration for Solids Analysis in mg/kg. In the event that the concentration of a constituent is above the 'Maximum Concentration for Solids Analysis' established for this project, then the soluble extractable levels of that constituent must be analyzed. To perform the soluble testing, the soil will undergo a Waste Extraction Test (WET) and the extractant will be tested and compared against the Soluble Threshold Limit Concentration (STLC) value(s). In the event that the screening limits are exceeded (or

there is no STLC value to compare against), the contractor can choose to determine natural background concentrations of the constituent(s) in the region of the project site. This background level can be determined through composite testing of the new placement site. If the background value is found higher than limits provided, the contractor can use the information as justification of potentially exceeding the limit(s). This justification must be submitted to the contracting officer for review and final determination of acceptability will be provided to the contractor.

Constituent	USEPA ^c Method No.	Maximum Concentration for Soil Analysis (mg/kg)	Reference	Maximum Concentration for STLC Extractable Analysis (mg/L)	Reference
Metals					
Arsenic	6010D	0.36	a	5	c
Cadmium	6010D	1.9	d	1	c
Total Chromium	6010D	160	d	5	c
Copper	6010D	180	d	25	c
Lead	6010D	320	a	5	c
Mercury (solid)	7471B	4.4	a	0.2	c
Nickel	6010D	86	d	20	c
Selenium	6010D	2.4	d	1	c
Silver	6010D	2.5	d	5	c
Zinc	6010D	340	a	250	c
pH	9045	2.5-12.5	c		
Chromium (VI)	7196	6.2	a	5	c
Total Petroleum Hydrocarbons (TPHs)					
TPH-GRO (Gasoline range: C6-C10)	8015D	100	d		
TPH-DRO (Diesel range: C10-C20)	8015D	260	d		
TPH-ORO (Oil range: C20-C35)	8015D	1600	d		
Polynuclear Aromatic Hydrocarbons (PAHs)					
Acenaphthene	8270E* or 8310	6.4	d		
Anthracene	8270E* or 8310	1.9			
Benzo(a)anthracene	8270E* or 8310	0.63			
Benzo(b)fluoranthene	8270E* or 8310	1.1			
Benzo(k)fluoranthene	8270E* or 8310	2.8			
Benzo(a)pyrene	8270E* or 8310	0.11			
Chrysene	8270E* or 8310	2.2			
Dibenz(a,h)anthracene	8270E* or 8310	0.11			
Fluoranthene	8270E* or 8310	0.69			
Fluorene	8270E* or 8310	6			
Indeno(1,2,3-cd)pyrene	8270E* or 8310	0.48			
Naphthalene	8270E* or 8310	0.042			
Pyrene	8270E* or 8310	45			
Polychlorinated Biphenyls (PCBs)					
Aroclor 1016	8082A	17	a	5 for sum of all listed PCBs	c
Aroclor 1221	8082A	0.53			
Aroclor 1232	8082A	0.49			
Aroclor 1242	8082A	0.58			
Aroclor 1248	8082A	0.58			
Aroclor 1254	8082A	0.59			
Aroclor 1260	8082A	0.6			
Organochlorine Pesticides					
Aldrin	8081B	0.18	b	0.14	c
Alpha - Hexachlorocyclohexane (Alpha BHC)	8081B	0.36	b		
Beta - Hexachlorocyclohexane (Beta BHC)	8081B	1.3	b		
Gamma - Hexachlorocyclohexane (Gamma BHC) (Lindane)	8081B	2.5	b	0.4	c
Chlordane	8081B	7.7	b	0.25	c
4,4-DDD	8081B	6.2	a	0.1 SUM of DDD+DDE+DDT	c
4,4-DDE	8081B	9.3	a		
4,4-DDT	8081B	7.1	a		
Dieldrin	8081B	0.093	a	0.8	c
Endosulfan	8081B	6000	a		
Endrin	8081B	160	a	0.02	

Heptachlor	8081B	0.63	b	0.47	c
Heptachlor epoxide	8081B	0.33	b		
Methoxychlor	8081B	2600	a	10	c
Toxaphene	8081B	1.2	a	0.5	c
Chlorinated Herbicides					
2,4-D (2,4-Dichlorophenoxyacetic acid)	8151A	7300	a	10	c
Dalapon	8151A	16000	a		
2,4-DB(4-[2,4-Dichlorophenoxy]butyric Acid)	8151A	16000	a		
Dicamba	8151A	16000	a		
Dinoseb	8151A	530	a		
2,4,5-T(2,4,5-Trichlorophenoxyacetic Acid) (Silvex)	8151A	4200	a		

References:

a - California Department of Toxic Substances Control (DTSC), Human and Ecological Risk Office (HERO), 2020, Human Health Risk Assessment (HHRA) Note Number 3, DTSC-modified Screening Levels (DTSC-SL); dated June 2020. (Table 1).

b - United States Environmental Protection Agency (USEPA), 2021, Regional Screening Levels (RSL) Resident Soil Table; dated November 2021.

c - California Code of Regulations, Title 22 Division 4.5 Chapter 11 Article 3, 2014 (Table I, II, and III).

d - California Regional Water Quality Control Board - San Francisco Bay Region, 2019, Environmental Screening Levels - Tier 1 ESLs (Rev. 2); dated January 2019.

e - US EPA's Test Methods for Evaluating Solid Waste (SW-846)

* Preferred method

12.4-2.3.5 SAMPLING COST

All costs associated with the chemical sampling to be included in the Borrow Area Chemical Suitability Certification Report will be coordinated and paid for by the contractor.

12.4-2.3.6 OFFSITE BORROW SITE CHEMICAL SUITABILITY CERTIFICATION REPORT

A report detailing the chemical testing performed and confirming the chemical suitability of the offsite borrow site soil is to be provided to the Contracting Officer within 45 calendar days after sample collection and at least 30 days prior to the first scheduled date for importing offsite borrow material. The report must include, but is not limited to the following: all chemical testing results with a section describing how the results compare to the screening limits, a map of sample locations with GPS coordinates, a brief summary of sampling activities, sample composite details, and any other pertinent information. This report must be certified by a California-licensed

professional engineer or geologist.

The report will include all laboratory chemical results and outlined in this specification. The results must be compared against the values provided in the "Imported Fill Chemical Screening Limits."

In addition to the chemical result comparison, additional location information (e.g. soil history, date of sampling, etc.) and commercial contact information (e.g. company name, laboratory used for testing, etc.) must be provided in the report. Material from an offsite borrow site can be brought onsite only after the Contracting Officer has provided approval to the report. It is the Contractor's responsibility to allow ample time for the Contracting Officer to review and approve the report and avoid any project delays.

12.4-3 EXECUTION

12.4-3.1 TOLERANCES

All embankments (prior to placement of surfacing) and backfill must be constructed to the grades, lines, and cross-sections shown on the Plans, and if not shown on the Plans, as determined by Contractor's Government-reviewed pre-construction surveys. The levee side slopes must have a tolerance of 0 to plus 0.4 feet for final dressing (measured perpendicular to the slope). The levee crown must have a tolerance of 0 to plus 0.1 feet above and 0 feet below. These tolerances will be allowed provided that any excess material is so distributed that the crown and slopes of the levee drain and that there are no humps or depressions in any surfaces.

A tolerance of 0.2 feet above or below the prescribed grade will be allowed for finished earth surfaces outside the levee embankment provided that the surface drains away from the levee in the direction indicated on the Plans with no abrupt humps or depressions.

12.4-3.2 PREPARATION OF FOUNDATION AND PARTIAL FILL SURFACES

12.4-3.2.1 FOUNDATION PREPARATION

After excavation or stripping (as described in Caltrans Standard Specification 17-2 Clearing and Grubbing) of the embankment and foundation area to the extent indicated or otherwise required, the sides of stump holes, test pits, and other similar cavities or depressions must be broken down so as to flatten out the slopes to no steeper than 1H:1V, and the sides of the cut or hole must be scarified to provide bond between the foundation material and the fill. Unless otherwise directed, each depression must be filled with the same material type that is to be placed immediately above the foundation. For depression deeper than 1-ft, the fill must be benched and/or keyed, placed in layers, moisture conditioned, and compacted in accordance with the applicable provisions of these Specifications for the specific material type. Materials which cannot be compacted by roller equipment because of inadequate clearances must be compacted with power tampers in accordance with Paragraph 12.4-3.6 COMPACTION for the specific material type.

any section of the embankment, or prior to placement of forms and reinforcement if beneath a structure, the foundation of such section must be loosened thoroughly by scarifying, plowing, discing, or harrowing to a minimum depth of 6 inches, and the moisture content must be adjusted to the amount specified in Paragraph 12.4-3.5 MOISTURE CONTROL for the appropriate type of material. Prior to placement of compacted fill or structural components, the Contracting Officer must inspect the foundation and give approval to the Contractor. The top of cutoff walls do not require scarifying, plowing, discing, harrowing, or moisture conditioning. After removal of roots or other debris turned up in the process of loosening, the entire surface of the foundation area must be compacted to the minimum specified percentage of the maximum dry density. Immediately prior to placement of compacted fill on or against the surfaces of any partially filled section, all soft or loose material, all material containing cracks or gullies, and all material that does not conform with the specified zoning of the embankment must be removed. The remaining surface of the partially filled section must be loosened by scarifying, plowing, discing or harrowing to a minimum depth of 6 inches, and the moisture content must be adjusted as specified in Paragraph 12.4-3.5 MOISTURE CONTROL for the appropriate type of material. The surface of the partially filled section upon which fill is to be placed, must then be compacted as hereinafter specified for the appropriate type of fill. No separate payment will be made for loosening and rolling the foundation area or the surfaces of partially filled sections, but the entire cost thereof must be included in the applicable contract price.

12.4-3.2.1.1 COMPACTION OF COHESIONLESS SOIL SUBGRADES

For the purpose of determining compliance with applicable compaction criteria in accordance with Paragraph 12.4-3.6.2, cohesionless soils in the subgrade are defined as soils classified in accordance with ASTM D2487 as GW, GP, SW and SP. Soils classified as GM, SM, GW-GM, GP-GM, SW-SM, and SP-SM may be identified as cohesionless only if they contain less than 20% fines (soil fraction passing the No. 200 sieve) by weight and a well-defined maximum dry density cannot be obtained.

Compaction of subgrade formed by cohesionless soils as defined above must comply with the procedures in Paragraph 12.4-3.2.1 FOUNDATION PREPARATION if a well-defined maximum dry density can be obtained. If a well-defined maximum dry density cannot be obtained, after scarifying as specified, the cohesionless soils are to be moisture conditioned according to Paragraph 12.4-3.5 MOISTURE CONTROL except that moisture content must be between 4.0 and 6.0% as determined by ASTM D2216 or ASTM D4643. If ASTM D4643 test method is used, a correlation between this method and D2216 test method must be established and reviewed by the Government. The moisture conditioned foundation surface must be compacted as follows: Apply a minimum of 6 passes with the vibratory roller specified in Paragraph 12.4-3.6.1.2. After the application of 6 passes, continue applying successive compaction roller passes until the dry density of the soil does not increase by more than 0.5 pounds per cubic foot per pass when tested with a nuclear density gauge in accordance with ASTM D6938.

12.4-3.2.2 BENCHING

Benching into the existing levee embankment or existing side slopes is required in order to place and compact Type 1 and Type 2 material in horizontal layers. Each layer of fill material applied on a levee must be benched into the levee section individually in four (4) to six (6) inch uncompacted layers.

12.4-3.2.3 PREPARATION OF CUTOFF WALL WORKING SURFACE TO RECEIVE EMBANKMENT FILL

The levee degrade/working surface must be cleaned of excess bentonite and bentonite-cement affected soils and debris prior to placement of embankment fill and must be prepared as specified in Paragraph 12.4-3.2.1 FOUNDATION PREPARATION. Bentonite and bentonite-cement affected soils will not be allowed to remain on the working surface without adequate blending to meet the Levee Fill and Moisture Content requirements of these Specifications.

12.4-3.2.4 SHORING AND SHEETING

Stability of temporary embankment excavations required for utility removal and replacement must be maintained and monitored by the Contractor.

In addition to EM 385-1-1 and other requirements set forth in this contract, the Contractor must submit a Shoring and Sheet Piling Plan that includes drawings and calculations, certified by a registered civil engineer authorized to practice in the State of California, and describes the methods for shoring and sheet piling of excavations if required. Drawings must include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations must include data and references used and include provisions in the shoring and sheet piling plan that will accomplish the following:

- a. Prevent undermining of embankments, roads, railways, or structures.
- b. Prevent slippage or movement in embankments adjacent to the excavation.
- c. Prevent slippage or movement in embankments during utility replacement.

12.4-3.3 EXCAVATION

Excavation consists of the removal of the existing levee crown, excavation as necessary to key and bench fills, and removal of objectionable and unsuitable materials, and excavation for pipe removal and/or installation.

12.4-3.3.1 LEVEE CROWN DEGRADE

Levee crown degrade consists of the removal of the existing levee crown to the lines and grades shown on the Plans. Crown surfacing and roadway removal and salvage must be performed in accordance with the Plans and these Specifications.

Materials obtained from project excavations that do not meet the requirements for Levee Embankment Fill (Soil Type 2) or Random Fill and/or excess project materials shall be disposed of in accordance with the Plans and these Specifications.

excavations become the property of the Contractor and must be disposed of off-site in a legal manner.

Levee degrade material can be used as Soil Type 2 and as Random Fill so long as it meets or can be blended to meet the requirements indicated in Paragraph 12.4-2.2, Types of Fill Materials, of these Specifications.

Contractor may modify the working surface elevations indicated on the plans based on the capabilities of the Contractor's cutoff wall construction equipment. For mix-in-place wall construction methods, Contractor must submit a plan for any proposed modification to the working surface elevations to the Government for review. The Contractor's plan must include the Contractor's proposed working surface elevations, the station limits where the change is proposed, proposed pay lines for cutoff wall, and the cutoff wall quantity affected by the change. Modification of the working surface may not be proposed by the Contractor with a Construction Incentive Change Proposal (CICP) as defined in the Contract Documents.

12.4-3.3.2 OVER-EXCAVATION

12.4-3.3.2.1 WITHIN LIMITS OF LEVEE FOUNDATION OR STRUCTURES

Over-excavation within the limits of the foundations of levees, structures and areas to receive fill must be backfilled to grade with Type 1 fill unless otherwise directed by the Government, keyed into adjacent ground, placed in loose lifts not exceeding six inches and compacted in accordance with this Specification. Keying of fill must be in accordance with the details shown on the Plans.

12.4-3.3.3 SLOPES AND SURCHARGES

Temporary excavation slopes must not be steeper than the specified finished slope or the specified construction slope, as shown on the plans.

Temporary or permanent construction slopes, or cutoff wall trench sidewalls, must not be surcharged with excavated or stockpiled material, or with heavy construction equipment, which would have the same effect as the surcharge material. The toe of stockpiled material must be maintained a minimum distance back from the top of the finished excavation equal to the depth of the excavation. The maximum height of such stockpile without causing instability of the excavation slope is determined by the Contractor. Any slide or other adverse conditions caused by failure of the Contractor to maintain these conditions are be considered the responsibility of the Contractor and remedial measures are at the Contractor's expense.

12.4-3.3.4 UTILITIES

Excavations for utility removal and installation must be as specified on the Plans and in these Specifications.

Excavate to the dimensions indicated or to safe limits if dimensions are not provided. All excavations necessary for utility removal and installation must meet OSHA and EM 385-1-1 standards. Grade bottom of trenches to provide uniform support for each section of pipe as shown on the Plans. Subgrade must be compacted as specified in Paragraph 12.4-3.2.1 FOUNDATION PREPARATION. Pipes must be uniformly supported for the entire length. Rock, where encountered, must be excavated to a depth of at least 6 inches below the bottom of the pipe or structure.

Pipe bed must be uniform and cleared of any loose material prior to placement of pipe.

12.4-3.3.5 TREE REMOVAL

Excavations for tree removal shall meet the requirements of EM 1110-2-18 and include the following basic requirements.

- i. By excavation, remove the trunk (or stem), stump, rootball, and all roots with diameters greater than 1/2 inch. All such roots in, or within 15 ft of levee improvements, must be completely removed.
- ii. Assure that the resulting void is free of organic debris.
- iii. Fill and compact the void in accordance with Section 12.4-3.6 Compaction.

12.4-3.4 PLACEMENT AND SPREADING

12.4-3.4.1 GENERAL

No fill is to be placed on any part of the embankment foundation or levee degrade surface until such areas have been inspected by the Contracting Officer.

12.4-3.4.1.1 GRADATION AND DISTRIBUTION

The gradation and distribution of materials must be such that the levee embankment and other fills will be free from lenses and layers of material differing substantially in texture or gradation from surrounding material of the same class. If lenses or layers of materials differing substantially in texture or gradation from surrounding material occur in the spread material, the layer must be removed, blended, and tested for suitability prior to replacement. Screening of oversized material and/or blending of materials is to be performed, if required to meet the specified gradation limits, at borrow source or in approved stockpile areas prior to placement in the levee. During the placement and spreading process, the Contractor must maintain at all times a force of workers adequate to remove oversized particles, oversized roots, debris, rubble, trash, deleterious items, concentrations of organic material, oversized stones, and all oversized rock fragments from all levee embankment materials. The maximum allowed particle size for the appropriate fill material type is as indicated in Paragraph 12.4-2.2 TYPES OF FILL MATERIALS. Pockets or lenses of organic materials are not acceptable and must be removed from the fill.

12.4-3.4.1.2 FOUNDATIONS AND PARTIAL EMBANKMENT FILLS

The foundations and all partial embankments receiving fill must be kept thoroughly

drained. Placement operations will be such as to avoid mixing of materials from adjacent sections as much as practicable.

12.4-3.4.1.3 EQUIPMENT TRAFFIC

Equipment traffic on any embankment zone must be routed to minimize rutting of placed fill and to distribute the compactive effort as much as practicable. Ruts formed in the surface of any layer of spread material must be filled before that material is compacted. If the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface must be loosened by scarifying or other reviewed methods before material for the succeeding layer is placed.

12.4-3.4.2 PLACEMENT OF EMBANKMENT AND STRUCTURAL BACKFILL

Embankment or backfill must not be placed on or against concrete less than 7 days after placement against concrete that has not reached or 70 percent of the design strength, whichever takes longer, without prior approval by the Government. Crawler-type tractors, vibratory equipment and other similar compaction equipment cannot be used within 4 feet of any completed or partially completed structure. Compaction within 4 feet of completed or partially completed structures can be accomplished by the use of mechanical hand tampers, vibrating plates, or other approved methods and equipment. The lift thickness within 4 feet of completed or partially completed structures must be 4 inches loose maximum. The Contractor must ensure that compaction operations do not damage any existing utilities or structures. Any damage caused by the Contractor's operation must be repaired at the Contractor's expense.

12.4-3.4.3 FILL MATERIALS

Levee Embankment Fill (Soil Type 1), Levee Embankment Fill (Soil Type 2) and other fills must be placed and spread in layers not more than 6 inches in uncompacted thickness, except within four (4) feet of structure, the uncompacted layer thickness must be reduced to four (4) inches maximum unless otherwise indicated on the plans.

12.4-3.4.4 FILL MATERIALS

The temporary soil cap must be uncompacted Levee Embankment Fill (Soil Type 1) placed to the thickness indicated on the Plans so as to not disturb completed slurry cutoff walls. The Levee Embankment Fill (Soil Type 1) used for the temporary soil cap must be removed prior to placing compacted levee embankment fill.

12.4-3.5 MOISTURE CONTROL

12.4-3.5.1 GENERAL

The materials in each layer of the fill must contain the specified amount of moisture, within the limits specified below. Material that is not within the specified moisture content limits outlined below after compaction must be reworked to obtain the specified moisture content, regardless of density.

12.4-3.5.1.1 INSUFFICIENT MOISTURE FOR SUITABLE BOND

The materials in each layer of the fill must contain the specified amount of moisture, within the limits specified below. Material that is not within the specified moisture content limits outlined below after compaction must be reworked to obtain the specified moisture content, regardless of density.

12.4-3.5.1.2 EXCESSIVE MOISTURE FOR SUITABLE BOND

If the top or contact surfaces of partially filled sections do not meet the specified moisture range, the wet material must be scarified and permitted to dry, assisted by discing or harrowing, if necessary, to a minimum depth of six inches. The material must be dried to an acceptable moisture range, and compacted in accordance with the applicable requirements of Paragraph 12.4-3.6 COMPACTION.

12.4-3.5.1.3 DRYING WET MATERIAL

Material that is too wet must be substantially dried in the stockpile area or borrow area prior to bringing to the levee embankment. Drying can be assisted by discing or harrowing, if necessary, until the moisture content is reduced to an amount that will require minimal processing once the material is placed.

12.4-3.5.1.4 INCREASING MOISTURE IN DRY MATERIAL

The moisture content of material that is too dry must be adjusted in the stockpile area or the borrow area prior to bringing to the levee embankment. The Contractor can add water to the fill material and by harrowing, or other approved methods, work the moisture into the material until a uniform distribution of moisture is obtained that will require minimal processing once the material is placed. Water applied on a layer of fill must be accurately controlled in amount so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, the rolling on that section of the embankment must be delayed until the moisture content of the materials is reduced to an amount within the specified limits.

12.4-3.5.2 MOISTURE CONTENT REQUIREMENTS

12.4-3.5.2.1 LEVEE EMBANKMENT FILL (SOIL TYPE 1), LEVEE EMBANKMENT FILL (SOIL TYPE 2) AND RANDOM FILL SOILS

The moisture content after compaction must be within the limits of one percentage point below optimum moisture content to above optimum moisture content as determined by ASTM D698 for subgrade to receive fill, levee embankment, ramps, structural backfill, utility backfill and random fill.

12.4-3.6 COMPACTION

12.4-3.6.1 COMPACTION EQUIPMENT

Compaction equipment must conform to the following requirements and must be used as prescribed in subsequent paragraphs.

12.4-3.6.1.1 TAMPING ROLLERS

Tamping rollers must be as follows:

- a. Self-propelled - Self-propelled tamping rollers must be capable of at least the compactive effort of a Caterpillar Model 825 Soil Compactor, or larger if required to achieve the specified relative compaction. The compactor must be fitted at the start of the work with unused tamping feet. Tamping feet must be maintained at a length that penetrates the entire uncompacted lift thickness. Tamping rollers must be operated at speeds between 3 and 5 miles per hour. The Government has the authority to limit or eliminate the use of self-propelled rollers if they are found to cause shearing or laminations of the compacted fill.
- b. Self-propelled Low Ground Pressure - Low ground pressure self-propelled tamping rollers for compacting initial fill over cutoff wall in accordance with Section 12.4-3.6.3 must have a minimum weight of 26,000 pounds. Tamping rollers must be operated at speeds between 3 and 5 miles per hour. Equipment must be operated parallel to the wall alignment with the compaction drum spanning over the width of the cutoff wall to prevent shearing or deformation of the top of cutoff wall. The Government has the authority to limit or eliminate the use of self-propelled rollers if they are found to cause shearing or laminations of the compacted fill.

12.4-3.6.1.2 VIBRATORY ROLLERS

Vibratory rollers for compacting aggregate base, pervious sand and gravel fills, and filter and transition drainage layers, must be equipped with a smooth steel compaction drum and must be operated at a frequency of vibration during compaction operations between 1100 and 1500 vpm. Vibratory rollers may be self-propelled and must have an unsprung drum weight that is a minimum of 60 percent of the rollers' static weight. Rollers for compacting aggregate base layers must have a minimum static weight of 20,000 pounds, a minimum dynamic force of 40,000 pounds when operating at 1400 vpm, and an applied force not less than 9,000 pounds per foot of compaction drum length. Rollers for compacting filter and drainage layers must have a minimum static weight of 8,000 pounds, a minimum dynamic force of 16,000 pounds when operating at 1400 vpm, and an applied force not less than 5,000 pounds nor greater than 9,000 pounds per foot of compaction drum length. The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the fill zone within which it is operating. Rollers must be operated at speeds not to exceed 1.5 mph. The equipment manufacturer must furnish sufficient data, Plans, and computation for verification of the above specifications, and the character and efficiency of this equipment must be subject to review.

12.4-3.6.1.3 RUBBER-TIRED ROLLERS

Rubber-tired rollers must have a minimum of four wheels equipped with pneumatic tires. The tires must be of such size and ply as to be capable of being operated at tire pressures between 80 and 100 psi at a 25,000 pound wheel load. The roller wheels

must be located abreast and so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels must be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the rated tire width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller must be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Government, from 18,000 to 25,000 pounds. The character and efficiency of this equipment is subject to review by the Government.

12.4-3.6.1.4 HAND OPERATED COMPACTORS

Compaction of material in areas where it is impracticable to use a roller or tractor compaction must be performed by the use of approved hand operated power compactors.

- a. Power Tampers: Power tampers must be hand operated equipment capable of compacting material in confined areas. The compactors must be either an internal combustion or pneumatic activated tamper. Tampers must have sufficient weight and striking power to produce the specified compaction. The character and efficiency of this equipment is subject to the review by the Government.
- b. Vibratory Plate Compactor: Vibratory compactors operated by hand in confined areas must utilize the oscillating cam principle and must deliver an impact of not less than 2000 lbf at a rate of approximately 2000 impulses per minute. The character and efficiency of this equipment is subject to the review by the Government.

12.4-3.6.1.5 SPRINKLING EQUIPMENT

Sprinkling equipment must consist of tank trucks, pressure distributors or other equipment designed to apply water uniformly and in controlled quantities to variable width of surface.

12.4-3.6.1.6 MISCELLANEOUS EQUIPMENT

Scarifiers, disks, spring-tooth or spike-tooth harrows, spreaders, and other equipment must be suitable for use in embankment construction. Equipment used for processing fill material must be capable of penetrating the full loose lift thickness of the specific material type.

12.4-3.6.2 COMPACTION OF FILL

After a layer of material has been dumped and spread, it must be harrowed to break up the fill materials to eliminate all clods and to obtain uniform moisture distribution. Harrowing must be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up of the materials, additional passes of the harrow must be required.

following minimum requirements (maximum dry density in accordance with ASTM D698):

Location	Percent of the Maximum Dry Density
Subgrade to Receive Engineered Fill	95 percent
12 Inches Beneath Concrete Structure	100 percent
Levee Embankment, Ramp Fill	97 percent
Structural Backfill and Utility Trench and surfacing	97 percent
12 Inches Beneath Aggregate Base or Aggregate surfacing	100 percent
Random, Non-Structural Fill within the Project	92 percent

12.4-3.6.3 PLACEMENT OF COMPACTION OF INITIAL BACKFILL OVER CUTOFF WALLS

The initial fill over a cutoff wall (not less than eight (8) feet and not more than ten (10) feet wide centered on cutoff wall alignment) must be placed in two equal lifts, each lift not to exceed 12 inches following compaction. Each lift must be compacted by four (4) complete passes for the initial (lower) lift and a minimum of six (6) passes for the second (upper) lift. Compaction equipment must be self-propelled low ground pressure tamping roller or approved equal. Operate equipment such that the strip being traversed by the equipment overlaps the previously compacted strip by a minimum of three (3) feet. Fill material above this initial fill must be placed and compacted in accordance with paragraphs 12.4-3.4.2, 12.4-3.4.3, and 12.4-3.6.2 of this specification.

12.4-3.7 STOCKPILES

Levee degrade material may not be side cast onto levee slopes during construction, except on a limited temporary basis for the purpose of widening the working platform, provided that (1) sidecast material may not roll beyond the construction limits, enter streams, enter private properties, or contribute to pollution, (2) sidecast material may not be placed within the drip line of trees that are to remain, and (3) sidecast material must be completely removed prior to reconstructing the levee. Silt fences must not be overloaded and must remain upright and functional at all times. Contractor is to conduct a daily inspection to identify knocked-down silt fence and make repairs. Levee Embankment Fill (Soil Type 2) must be stockpiled within the designated staging areas as shown on the plans or disposed of offsite as specified and

in a legal manner.

12.4-3.8 CONTROLLED LEVEE DEGRADE

Controlled levee degrade is required for up to 450 linear feet. The exact locations where controlled levee degrade will be performed are identified on the Drawings.

12.4-3.9 FIELD QUALITY CONTROL

12.4-3.9.1 GENERAL

As a part of the Contractor Quality Control (CQC) system, the Contractor must establish and maintain field quality control for foundation preparation, embankment and backfill operations to assure compliance with contract requirements and maintain detailed records of field quality control for all operations. Approximately 20 percent of tested locations may be selected for quality assurance by the Government.

Submit all quality control testing results in accordance with Paragraph 12.4-3.9.3 REPORTING. Testing laboratories must meet the requirement of ASTM D3740, ER 1110-1-261 and must be a US Army Corps of Engineers Materials Testing Center (MTC) approved laboratory. Supervision of tests and report preparation must be by a professional civil or geotechnical engineer licensed in the State of California. All reports must bear said professional engineer's signature and stamp. Distribution of the copies to the Government must be within 24 hours after sampling or initiating the test, except for test requirements that exceed 24 hours. For tests exceeding 24 hours, distribution must be within 24 hours after completion of the test. All quality control test reports must include the station, offset, and elevation for each test.

12.4-3.9.2 EMBANKMENT AND FILL TESTING

The Contractor must perform sufficient testing to ensure that the embankment is being constructed as specified. Testing locations can be directed by the Contracting Officer. Station, offset, and elevation must be recorded for each testing location. The testing program specified below must be considered the minimum acceptable frequency of testing. This does not relieve the Contractor from the responsibility of performing additional testing if required to ensure compliance with these Specifications.

a. Fill Material Testing

(1) Moisture Density Relationships. The moisture-density relations for all soils must be determined in accordance with ASTM D698 (a minimum of five (5) five-point compaction tests). The moisture-density curves will be compiled to form a family of curves which will be utilized to estimate optimum properties (maximum dry density and optimum moisture content) to be used with field density tests. A family of curves for each borrow site must be developed prior to importing borrow material onto the site and updated weekly as specified in Paragraph 12.4-1.4.11.

TEST METHOD	FREQUENCY
Moisture Density Relationship (ASTM	Minimum of five (5) tests on

D698)	representative samples of each type of fill material used. One test for every 5,000 cubic yards fill placed with a minimum of one test per shift.
Soil Gradation (ASTM D6913 and D1140), Atterberg Limits (ASTM D4318, wet preparation method), and Soil Classification (ASTM D2487)	One test for each moisture density relationship

(2) Water (Moisture) Content Tests. Determination of water content is to be performed in accordance with ASTM D2216. ASTM D4643 may be used when rapid moisture content results are needed. If ASTM D4643 test method is used, a correlation between this method and D2216 test method must be established and reviewed by the Government. One water content test will be performed for each in-place density test at the location of the in-place density test. Backfill and fills not meeting the required specifications for water content must be retested after corrective measures have been applied.

(3) In-place Density and Soil Classification Testing. The minimum in-place density and soil classification testing is shown in the table below. The horizontal locations of tests must be randomly staggered in the fill. At each field density test location, soil samples must be obtained for two-point compaction test and moisture test. For two-point compaction tests, one moisture content must be at or near the in situ moisture content (but not wet of optimum) and the other moisture content must be between 2% and 3% below the first, in accordance with EM 1110-2-1911, Appendix B-2.c.(1). Additional five-point compaction curves must be performed when two-point compaction tests performed as part of field density testing do not match an existing five-point curve within the family of curves. Fill not meeting the required specifications for in-place density must be retested after additional compaction has been completed.

TEST METHOD	FREQUENCY
Nuclear Method (ASTM D6938) or Sand Cone (ASTM D1556)	One (1) In-Place Density Test for every 500 cubic yards of completed fill unless otherwise specified. One (1) In-Place Density Test for every 500 square yards of subgrade to receive fill. Additionally, at least one (1) test for each lift of fill placed and material type,

	except that for filling voids created by tree stump removal, perform at least one (1) test per (5) lifts not to exceed 2 feet in compacted thickness.
Sand Cone (ASTM D1556)	One test for every five (5) nuclear method tests and a minimum of one (1) test per shift and material type.
Two-Point Compaction (EM 1110-2-1911, App. B)	At the location of each In-Place Density Test.
Soil Gradation (ASTM D6913 and D1140) Atterberg Limit Tests (ASTM D4318, wet preparation method) Organic Content (ASTM D2974)	One (1) test for every 2,500 cubic yards of compacted fill at the location of the sand cone test. Minimum of one (1) test per shift and material type.

When the nuclear method is used for in-place density testing, the first test and every fifth test thereafter for each material type must include a sand cone correlation test in accordance with ASTM D1556. This applies to the nuclear density tests performed at 500 cubic yard intervals as specified above, but not to more frequent nuclear density tests that the Contractor may perform to more closely control the work.

Sand cone tests must be performed adjacent to the location of the nuclear test, include a nominal 6 inch diameter sand cone, and include a minimum wet soil weight of 6 pounds extracted from the hole. Nuclear density testing equipment cannot be used during rain. The density correlations must be submitted with test results within 3 working days after completing the test. Each transmittal including density test data must include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

- (i) Meter serial number and operators initials.
- (ii) Standard count for each test.
- (iii) Material type.
- (iv) Probe depth.
- (v) Moisture content by each test method and the deviation.
- (vi) Wet density by each test method and the deviation.

(vii)

Density sand calibration

When nuclear and sand-cone test results do not match, determination of compliance with specified density requirements must be based on the sand cone results. Nuclear test data must be adjusted based on the site-specific correlation to match the sand cone data.

12.4-3.9.3 REPORTING

On a daily basis, the Contractor must furnish (hard copy and electronic copy) the inspection records and all material testing results, the quantity of fill placed, as well as the records of corrective action taken.

12.5 EARTHWORK - CUTOFF WALL DEEP MIXING METHOD

12.5-1 GENERAL

12.5-1.1 GENERAL

The Contractor must furnish all labor, equipment, and materials necessary to plan, design, and construct the deep mix method (DMM) cutoff walls and associated testing, monitoring, sampling, and recording to meet the performance requirements outlined in these specifications.

Contractor must furnish explorations at 100-ft spacing along the proposed DMM alignment. Explorations must be completed in accordance with The DIPP requirements for Subsurface Drilling, Sampling, and Testing.

All work under this section must comply with the requirements of EM 385-1-1.

12.5-1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 13B-1 (2019; Errata 1 2020; Errata 2 2021, Errata 3 2023) Recommended Practice for Field Testing Water-Based Drilling Fluids

API Spec 13A (2019; Addendum 1 2020; Addendum 2 2022; Errata 1 2024) Specification for Drilling-Fluid Materials

ASTM INTERNATIONAL (ASTM)

ASTM C150/C150M (2024) Standard Specification for Portland Cement

ASTM D2113 (2014) Rock Core Drilling and Sampling of Rock for Site Investigation

ASTM D2166 (2024) Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

ASTM D4380 (2020) Standard Test Method for Density of Construction Slurries

ASTM D4832 (2023) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Cylindrical Test Cylinders

ASTM D5084 (2024) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2024) Safety and Occupational Health (SOH) Requirements

ER 1110-1-1807 (2023) Drilling and Invasive Activities at Dams and Levees

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020 (1983) Methods for Chemical Analysis of Water and Wastes

EPA 3005A (1992) Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy

EPA 3510C (1996) Separatory Funnel Liquid-Liquid Extraction

EPA 5030B (1996) Purge and Trap for Aqueous Samples

EPA 6010C (2000) Inductively Coupled Plasma-Atomic Emission Spectrometry

EPA Modified 8015 (1990) Nonhalogenated Organics Using Purge and Trap (GC/FID)

EPA 8041A (1990) Organophosphorus Compounds by Gas Chromatography: Capillary Column Technique

EPA 8081A (1996) Organochlorine Pesticides by Gas Chromatography

EPA 8260B (1996) Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

12.5-1.3 DEFINITIONS

12.5-1.3.1 ADMIXTURES

Ingredients in the grout other than binder, bentonite, and water. Admixtures can be fluidifiers, dispersants, or retarding, plugging, or bridging agents that permit efficient use of materials and proper workability of the grout.

12.5-1.3.2 BENTONITE

Bentonite is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite.

The Contractor must submit for review statement(s) signed by an authorized official to certify on behalf of the manufacturer of the materials that the products meet the requirements for "bentonite" specified herein. The statement must be dated after the Award of Contract, must state the Contractor's name and address, must name the project and location, and must list the specific requirements that are being certified.

12.5-1.3.3 BENTONITE SLURRY

Where bentonite slurry is used in the cutoff wall method, bentonite slurry is a colloidal mixture of bentonite (fully hydrated) and water and other suitable material prepared in accordance with API Spec 13A.

12.5-1.3.4 CEMENT SLURRY

Cement slurry is a colloidal mixture of Portland Cement Type II (per ASTM C150/C150M) and water and other suitable material.

12.5-1.3.5 BENTONITE/CEMENT SLURRY

Bentonite/Cement slurry is the colloidal mixture of bentonite, Portland Cement Type II, and water and other suitable material used for the construction of deep mix method (DMM) cutoff wall construction.

12.5-1.3.6 BINDER

Chemically reactive material (i.e., lime, Portland cement, gypsum, blast furnace slag, pozzolan or cementitious flyash (Class F or C), or other hardening reagents) that can be used for mixing with insitu soils to strengthen the soils and form soil mix columns.

12.5-1.3.7 SOIL MIX

In situ ground treatment in which fill and soil is thoroughly blended with cementitious and other materials homogeneously to reduce permeability and improve strength and compressibility characteristics.

12.5-1.3.8 CORE RUN

The maximum core run must be five (5) feet. The minimum core hole diameter must be 4-inches.

12.5-1.3.9 CORE RECOVERY

Core Recovery is defined as the (total length of recovered soil cement)/(total length of core run)x 100

12.5-1.4 SYSTEM DESCRIPTION

The work covered by this section consists of furnishing all plant, labor, equipment and materials; performing all operations, including quality control and quality acceptance testing; and preparation of an end-of-construction summary report and as-built Plans in connection with the construction of a soil-cement-bentonite (SCB) cutoff wall. The cutoff wall methodology presented in this section may be used for construction of any cutoff wall features in this project. The Contractor's submittals must indicate the selected method to be used and obtain Government approval prior to beginning that work.

Any references within this section to "cutoff wall" or "seepage cutoff wall" refers to a cutoff wall constructed using the methodologies of this section unless otherwise specified.

The Contractor must be fully responsible for the means and methodology for the construction of the required DMM walls. In addition, the CONTRACTOR is fully responsible for the DMM Wall mix design. The Contractor must perform all survey, layout, and utility clearance required for the DMM walls. The completed DMM walls must meet the performance criteria described within this specification.

12.5-1.4.1 DESIGN REQUIREMENTS

The SCB cutoff wall must be constructed using in situ soil mixing methods capable of meeting the requirements of this section and classified as either: Wet Rotary Shaft (WRS), Wet Rotary End (WRE), Wet Rotary and Jet End (WJE) or Wet Vertical Panel (WVP), as described in the Federal Highway Administration manual Deep Mixing For Embankment and Foundation Support (FHWA HRT-13-046). Methods that do not use mechanical soil cutting or mixing methods are not allowed. The SCB cutoff wall must be constructed in accordance with these specifications and as shown on the Plans. The design intent is to produce an incompressible, relatively low-strength, low-permeability, continuous cutoff wall. The SCB cutoff wall must be continuous between the starting and ending points for each alignment, with an appropriate overlap between elements and headings to ensure continuity to full depth. The cutoff wall must consist of a series of overlapping SCB elements, or panels, formed underground through and beneath the levee. Individual elements are joined utilizing overlaps, forming a continuous SCB mixed cutoff wall along the entire alignment.

12.5-1.4.2 ACCEPTANCE REQUIREMENTS

The Contracting Officer must make the determination as to whether the DMM walls satisfy the geometric, strength, permeability and uniformity acceptance criteria.

Final acceptance of the cutoff wall will be based on the Quality Control (CQC) Records as identified in the Rig-Shift Reports, Construction Quality Control test results, and Government's quality assurance test results.

Both Contractor and Government testing must demonstrate that the Contract requirements are met prior to acceptance of the work. If during the course of construction, the Contractor QC testing indicates noncompliance with these specifications, immediately notify the Contracting Officer in writing. Notification must include the remedial action to be taken to bring the work/products back into compliance.

The following is the acceptance criteria for the SCB cutoff wall. Items a. through h. below refer to both the demonstration section and the production cutoff wall. Refer to the entire specification and the Plans for all the Contract requirements.

- a. Wall bottom elevation: As shown on the Plans or as modified by the Contracting Officer based on exploratory borings provided by the Contractor, or as directed by the Contracting Officer.
- b. Width of wall: For all construction methodologies, except for WVP, a minimum 27 inch width of wall, as measured in the horizontal plane perpendicular to the wall alignment, is required. For WVP construction methodologies, a minimum 24-inch width of wall is required.
- c. Wall continuity: Continuity of the cutoff wall must be confirmed by a) constructing the panels with an overlap, and b) measuring and recording the verticality of the CSM leads during the forming of the wall. The

maximum incremental deviation (deviation with respect to the position of the adjacent panel) at any depth must not be greater than twenty (20) percent of the specified minimum wall thickness. The accumulated total deviation of any single panel from vertical must not exceed one (1) percent of the panel depth.

- d. Wet bulk sample unconfined compressive strength (by ASTM D2166): At 28 days, not less than 200 psi.
- e. Wet bulk sample permeability: Maximum 5×10^{-7} cm/sec at 28 days or sooner.
- f. In situ hydraulic conductivity: Not higher than 5×10^{-7} cm/sec for any single test.
- g. Mixing index with allowed deviation established during demonstration section (Mixing Index is defined in Mixing Index Development).
- h. Homogeneity which is defined as no unmixed soil inclusions greater than three inches consisting of native fine grained soils. Defects are defined as incomplete soil-mixed zones greater than 3-inches maximum diameter, as indicated by the cutoff wall cores and the downhole probe sensors. These include voids, seams, cracks or other fissures that indicate the presence of unmixed zones. Cracks that are caused by mechanical (i.e. from drill tooling) or hydraulic (i.e. hydro-fracturing) action during drilling of the borehole are not considered defects.

12.5-1.4.2.1 DEMONSTRATION SECTION

A Demonstration Section must be placed along the cutoff wall alignment shown on the plans and as indicated in these specifications. The demonstration section must meet the acceptance requirements stated above, and the additional testing requirements set in paragraph 12.5-3.5.1 DEMONSTRATION SECTION below. Portions of the demonstration section that do not meet the acceptance requirements will be rejected and must be repaired as specified in Paragraph 12.5-1.6.2 Rejected Work.

12.5-1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following must be submitted in accordance with Section 5-1.23 SUBMITTALS:

SD-01 Preconstruction Submittals

Implementation Plan; G

Quality Control Program; G

Qualification Submittal; G

Sample Quality Control Records; G

Sequence of Operations At Utility Line Crossings; G
Sampling Plan; G
High Pressure Operating Safety Plan; G
Cutoff Wall Surcharge Loading Plan; G
Demonstration Section Work Plan; G

SD-03 Product Data

Admixtures; G

SD-04 Samples

Wet Bulk Samples

Trial Mix Design

Chain of Custody Form for Quality Assurance Samples

SD-05 Design Data

Cutoff Wall SCB Material Mix Design; G

SD-06 Test Reports

Calibration Results

Water Quality Test Report

As-Built Profile of Cutoff Wall and End of Construction Summary Report; G

Daily Field Quality Control Reports

SCB Mix Design Test Report; G

Construction Quality Control Test Results; G

SD-07 Certificates

Cement Certification

Bentonite Certification

Admixture

12.5-1.6 QUALITY CONTROL

12.5-1.6.1 COORDINATION OF LABORATORIES

The CQC laboratory representative must meet weekly with the Government's quality assurance laboratory representative to coordinate all aspects of their work. The first meeting must be in person, subsequent meetings may be via teleconference or in person. Eliminate differences in sampling, handling, transporting, storing and testing methods. If discrepancies in the test results from the two labs are noted, the Manager of the Quality Control Laboratory and the Manager of the quality assurance Laboratory must visit and inspect each other's laboratory facilities for the purpose of eliminating the differences and discrepancies. The Manager of the Quality Control Laboratory must report the findings to the Contracting Officer.

Rejected work will be repaired by construction of a new heading between the last two locations of acceptable tests. The new heading will be constructed immediately adjacent to the rejected cutoff wall section on the waterside and must overlap and tie into accepted sections of the newly construction cutoff wall to provide a continuous cutoff wall. Submit a corrective action plan to the Government for review and approval within 48 hours of the work being rejected.

12.5-1.7 QUALIFICATIONS

12.5-1.7.1 CONTRACTOR

The Contractor's company, subcontractor, joint venture partner (JVP), or merged company (MC) must have experience in cutoff walls used for seepage control on levee projects within the last ten (10) years from this announcement. Multiple headings on any one contract must be considered as one construction project experience.

Deep Mix Method (DMM) cutoff wall construction project experience must include in-situ soil mixing methods classified as: Wet Rotary Shaft (WRS), Wet Rotary End (WRE), Wet Rotary and Jet End (WJE) or Wet Vertical Panel (WVP), as described in the Federal Highway Administration manual Deep Mixing for Embankment and Foundation Support. This experience must also include completed construction of at least two (2) DMM cutoff wall projects including, but not limited to, Deep Soil Mixing (DSM) / Cutter Soil Mixing (CSM) / One Pass Trenching (OPT) / Trench Cutting Re-Mixing Deep (TRD) method cutoff walls. This experience must include setting up and operating the batch plant and delivery system to the cutoff wall location, and all associated work with constructing the cutoff wall. For each of the two (2) projects the following cutoff wall standards must have been met to demonstrate sufficient capability:

- a. A minimum of 75 feet deep;
- b. A minimum of 24-inches wide;
- c. A minimum of 500 feet long;
- d. A maximum permeability of 1×10^{-6} cm/sec; and
- e. A minimum unconfined compressive strength of 50 psi at the end of the curing time period specified in the project's contractual requirements.

Submit Contractor's Qualifications for approval. Example projects provided must include documentation such as contract document excerpts, not to exceed 5 pages, for each project submitted which demonstrate cutoff wall length, width, depth, permeability, and strengths requirements, as appropriate, and laboratory and testing data for cutoff wall permeability and strengths, as appropriate. Additionally, each example project must include a point of contact that may be reached if needed to verify the data.

The Soil Mixing Equipment Operator(s) must have experience in using similar equipment as that to be used for this solicitation in a minimum of two successfully completed projects and a minimum of five years of experience similar to the projects described in Paragraph 12.5-1.7.1 CONTRACTOR. The projects listed in the resume must be similar to this solicitation including, but not limited to, comparable scope, complexity, and physical size.

12.5-1.7.3 SOIL MIXED GROUT PLANT OPERATOR

The Grout Plant Operator(s) must have experience in using similar grout plant equipment to be used for this solicitation in a minimum of two successfully completed projects and a minimum of five years of experience similar to the projects described in Paragraph 12.5-1.7.1 CONTRACTOR. The projects listed in the resume must be similar to this solicitation including, but not limited to, comparable scope, complexity and physical size.

12.5-1.7.4 SOIL MIXED CUTOFF WALL SPECIALIST

The Soil-Mixed Cutoff Wall Specialist(s) must be experienced in providing supervision of mix design and field control composition and mixing of the soil-cement or soil-cement bentonite using in situ soil mixing equipment. The projects listed in the resume must include a minimum of two successfully completed projects and a minimum of five years of experience on projects similar in scope, project type, physical size and complexity to this solicitation and meeting the project criteria in Paragraph 12.5-1.7.1 CONTRACTOR above. The experience must include but not limited to, the following: (1) controlling composition, mixing, placing, sampling, testing and maintaining bentonite/cement slurry; (2) supervision of alignment, verticality, and depth of soil mixing equipment; (3) controlling blending, mixing, sampling, and testing in-situ material; and (4) a thorough knowledge of soil mixing and cutoff wall construction equipment and material testing.

12.5-1.8 GENERAL CONDITIONS

12.5-1.8.1 ACCESS AND RAMPS

Construct temporary access and ramps for work related to this section in accordance with Caltrans Standard Specification Section 19 EARTHWORK and the associated Special Provisions.

12.5-1.8.2 PROTECTION OF EXISTING FACILITIES

Conduct construction in a manner that avoids damage to all existing facilities that are not designated for removal or reconstruction.

12.5-1.8.3 CONSTRUCTION METHODS

Construct the cutoff wall using in situ deep mixing methods. Perform cutoff wall construction using a soil mixing rig which utilizes augers, shear plates, cutting heads, cutting posts or other devices capable of shearing and blending the in situ soil to a condition which meets the requirements of this section.

12.5-1.8.4 SEQUENCING OF WORK

The Contractor must use multiple headings as needed to achieve the required schedule completion dates.

12.5-1.8.5 LINES AND GRADES

The DMM cutoff wall must be constructed to the lines, grades, and dimensions shown on the Plans, unless otherwise directed in writing by the Government. Any Contractor-proposed changes to the cutoff wall alignment shown on the Plans must be submitted by the Contractor and approved by the Contracting Officer prior to beginning excavation of the cutoff trench.

12.5-1.8.6 WATER FOR CONSTRUCTION

Refer to Caltrans Standard Specifications Section 10-4 WATER USAGE.

12.5-1.8.7 OBSTRUCTIONS AND REFUSAL

12.5-1.8.7.1 OBSTRUCTIONS

Culverts, standpipes, and other buried piping that are shown on the Plans and that are either to remain, to be protected, or to be removed and replaced as part of the work, must not be considered obstructions. Existing utilities shown on the Plans must not be considered obstructions. Man-made objects encountered within the zone excavated to degrade the levee (e.g., utilities and other facilities, etc.) must not be considered obstructions. The Contracting Officer is the sole judge of whether an obstruction has been encountered. An obstruction will not be considered unless it is the result of natural ground conditions and when using properly operated and maintained equipment. Past performance will be considered when determining whether the equipment is properly operated and maintained, including but not limited to specific rig performance, tooling, and soil conditions, etc. For an obstruction to be considered as such, the rate of cutting head advancement must be less than 6 inches vertical advancement in 15 minutes for vertically installed elements. The Contracting Officer will determine if additional efforts will be needed to obtain the design element depth. Additional efforts may include, but not be limited to, adding adjacent elements to obtain the design depth. Any of these efforts must not adversely affect the soil mixed element for meeting the specification requirements.

12.5-1.8.7.2 REFUSAL

The Contracting Officer will determine when refusal is reached. For refusal to be considered as such, the rate of cutting head advancement must be less than 6 inches vertical advancement in 15 minutes for vertically installed elements. Refusal will not be considered unless it is the result of natural ground conditions and when using properly operated and maintained equipment. Past performance will be considered when determining whether the equipment is properly operated and maintained, including but not limited to specific rig performance, tooling, and soil conditions, etc. The Contracting Officer is the sole judge of whether refusal has been encountered.

The Contracting Officer will determine if additional efforts will be needed to obtain

the design element depth. Additional efforts may include, but not be limited to, adding adjacent elements to obtain the design depth. Any of these efforts must not adversely affect the soil mixed element for meeting the specification requirements.

12.5-1.8.8 DEMONSTRATION SECTION

Construct a cutoff wall test section prior to construction of the production cutoff wall. The test section must be a minimum of 60 continuous linear feet of completed cutoff wall along the proposed alignment shown on the Drawings. Contractor must not proceed with production cutoff wall until after receipt of written acceptance of the Demonstration Section by the Contracting Officer. See paragraph 12.5-3.5, Installation, for requirements related to the test section. The terms Test Section and Demonstration Section are used interchangeably.

Submit for approval a report for the DMM Cutoff Wall Test Section. Report must include a cover letter describing the work performed signed by the DMM Cutoff Wall Specialist that provides a narrative of the cutoff wall construction including wall location, mix design, selection of parameters originally specified in wall construction, variations that occurred from the specified parameters during wall construction and a discussion on why the parameters were varied, results of contractor QC testing and discussion of when and where construction was halted, deviated from design lines and grades, obstructions were encountered, equipment breakdowns occurred, loss of fluid injection or any other notable occurrence that occurred during construction. Report must include a scaled drawing showing the location of the wall in plan view and the surveyed coordinates of the center of the outer two most augers for each panel, the limits of each test section, and all quality control data and core drilling and core hole testing required in these Specifications. The testing and documentation of the demonstration section cutoff wall mixed material must be in accordance with the requirements contained in (1) paragraph FIELD QUALITY CONTROL and (2) paragraph DEMONSTRATION SECTION.

12.5-1.9 MAINTENANCE

12.5-1.9.1 EXTRA MATERIALS

Maintain at the job site a sufficient quantity of raw materials and other supplies such that the work can proceed uninterrupted by material shortages. Modify the mix proportions and methods as needed, within allowable limits, to meet the required wall strength, permeability, continuity, and homogeneity even in difficult subsurface conditions. Perform additional tests necessary to verify compliance with the Acceptance criteria.

12.5-1.10 CONSTRUCTION QUALITY CONTROL TEST RESULTS

The results of all Construction Quality Control testing required in these Specifications must be furnished to the Contracting Officer, including sampling and testing of all water sources used for mixing backfill, coring, water tests, DMM cutoff wall backfill tests, and permeability testing of wet-bulk samples. The Contractor must furnish records of all observations, measurements, and tests performed, identified with the location, date, and time of testing. Each test report must be properly identified. Test methods used must be identified and test results must be recorded. Details 100 - 23

laboratory test procedures for performing permeability tests on wet-bulk samples must be provided. These records must be furnished no later than 24 hours after the tests, measurements, and/or observations are performed.

12.5-2 PRODUCTS

12.5-2.1 MATERIALS

12.5-2.1.1 MATERIAL STORAGE FACILITY

Provide all necessary materials, equipment and personnel to store the bentonite, cement and other additives under conditions to prevent moisture or other contaminants from interacting or mixing with the materials prior to use in the plant.

12.5-2.1.2 CEMENT

Cement must be Portland Cement Type I or Type II (per ASTM C150/C150M). Provide a record copy cement supplier written certificate specifying cement quality. The Cement Certification submittal must correspond to the current source of cement. Submit statement(s) signed by an authorized official to certify on behalf of the manufacturer of the materials attesting that the products meet specified requirements. The statement must be dated after the award of the Contract, must state the Contractor's name, address, must name the project and location, and must list the specific requirements which are being certified.

12.5-2.1.3 BENTONITE

Furnish a Bentonite Certification and a copy of the test reports from the bentonite supplier for each lot of bentonite shipped to the site stating that the bentonite complies with all applicable standards. The bentonite must be sodium cation base montmorillonite powder that conforms to API Spec 13A, Section 9. Bentonite must be new, pulverized, high-swelling natural sodium cation montmorillonite (Premium Grade Wyoming-type bentonite). Chemically treated bentonite will not be allowed. No bentonite from the bentonite manufacturer must be used prior to acceptance by the Contracting Officer. All bentonite must be subject to inspection, sampling, and verification of quality by Contractor QC testing and Government QA testing. Bentonite not meeting specifications must be promptly removed from the site and replaced with bentonite conforming to specification requirements at the Contractors expense. Protect bentonite from moisture during transit and storage. Submit statement(s) signed by an authorized official to certify on behalf of the manufacturer of the materials attesting that the products meet specified requirements. The statement must be dated after the award of the Contract, must state the Contractor's name, address, must name the project and location, and must list the specific requirements which are being

12.5-2.1.4 ADMIXTURES

Submit proposed use of admixtures, for Government approval. Provide written documentation supporting the proposed use of all admixtures. Documentation must address the effects of the admixture on the cutoff wall SCB material, long-term stability and the admixture and the SCB material, and any potential effects on the

natural environment. Peptizing or bulking agents must not be mixed with the cement or bentonite slurry. Admixtures must be proven with the trial design mixes. Use only admixtures approved by the Government. Retarders, fly ash, or other solids containing heavy metals are prohibited. Submit an Admixture Certification for each lot of admixtures.

12.5-2.1.5 GROUT

Cement-Bentonite Grout for the SCB walls must be a homogeneous mixture of cement, bentonite, water, and other additives.

Ensure that grout temperature remains between 35° and 90° F at all times prior to injection into the ground.

The grout must not have begun its initial set before it is injected into the ground.

12.5-2.2 WATER

12.5-2.2.1 SUPPLY

Refer to Caltrans Standard Specifications Section 10-4 WATER USAGE.

12.5-2.2.2 QUALITY

The water must be clean, fresh, and comply with the standards set below:

- a. A pH equal to 7.0 plus or minus 1.0. Test Method API RP 13B-1
- b. Total dissolved solids not greater than 500 parts per million. Test Method EPA 600/4-79/020 Method 160.1.
- c. Hardness less than or equal to 50 ppm. Test Method API RP 13B-1. (Recommendation Only)
- d. VOCs less than the MCL. Test Method EPA 5030B/EPA 8260B/EPA 5030B.
- e. TPH less than the MCL. Test Method EPA Modified 8015.
- f. Metals less than the MCL. Test Method EPA 3005A/EPA 6010C.
- g. Pesticides less than the MCL. Test Method EPA 3510C/EPA 8081A/EPA 8041A MCL = Maximum Contaminant Level

Water with hardness in excess of 50 ppm will be accepted for use based upon performance in the SCB mix as long as the required permeability standards specified herein for the in place SCB wall are achieved throughout the project. Water quality must be tested once every two weeks. Furnish water quality test results for water used for mixing the bentonite/cement slurry to assure conformance with the above limits.

Water used for production must come from the same source as water used for the mix design. Abide by any and all Federal, State of California, and local regulations and other requirements governing such use. Include the cost of all related fees in the bid items pertinent to the work. Water must not be taken from the river for construction activities, except when required for testing and with the Contracting Officer's approval. Water taken from the river for testing purposes must only be filled by hand, and mechanical pumps are prohibited. Submit a Water Quality Test Report presenting the results of the testing. If City of Sacramento municipal water is used, the Water Quality Test Report is not required.

Water for in-situ permeability testing must be from the same source as used for the batch plant and may not be delivered to the test holes in water

12.5-3 EXECUTION

12.5-3.1 MOBILIZATION

Mobilize equipment to the staging area after receiving approval from the Government and obtaining all necessary permits for equipment to construct the cutoff wall.

12.5-3.2 PREPARATION

12.5-3.2.1 IMPLEMENTATION PLAN

Submit for approval, a minimum of 40 days prior to start of cutoff wall construction, the methods, schedule and sequence of operations for construction of the cutoff wall, including but not limited to site access, working platform construction, wall layout, waste management, offsite disposal locations, slurry preparation batching, mixing, pumping, injection, and final grade closure. The schedule must also include information regarding equipment mobilization, equipment setup, demonstration section, production/installation headings, elements, etc., and verification testing. Include the layout of operations including working pads and associated levee excavation, if required, for the construction of the wall. Include storage areas, slurry preparation and mixing areas, access corridor, and location and sizes of all stationary equipment. Include scale drawings which depict material preparation and storage areas.

Submit data on equipment to be used in all sequences of the cutoff wall construction, including mixing, placement, and equipment to be used in the CQC testing. Include the location of the laboratory trailer/structure.

Submit a detailed description of the equipment and procedures to be used during the project including, but not limited to, construction of the cutoff wall and monitoring the quality control parameters outlined herein, and collecting samples for laboratory testing. Procedures must include methods for locating the wall in the field and confirming that the wall is plumb. Also submit the proposed mix design and construction methods needed to comply with the Plans and Specifications. The calibration of the bentonite and cement slurry mixing plants and blending of the bentonite and cement slurry must be documented. Include data on equipment such as mixers capable of producing both a stable colloidal suspension of bentonite slurry and

cement slurry mixture; storage facilities including tanks and methods of agitation; delivery methods and equipment; spillage, and containment facilities to control spillage.

Submit a soil mix design including constituents, relative proportions, the required mixing time, and volume ratio for a deep mixed element.

Submit a revised Implementation Plan after completing the DMM demonstration section. Submit the revised plan after completion of the demonstration section but prior to the start of production wall construction.

12.5-3.2.2 QUALITY CONTROL PLAN

Submit a Quality Control (QC) Plan that includes but is not limited to the following:

- a. QC Manager. The QC Manager must have significant experience on at least five (5) DMM projects.
- b. Names and qualifications of any subcontractors used for QC activities.
- c. Names and qualification of independent laboratory for QC testing.
- d. Details of all means and methods proposed for QC activities, including surveying, alignment and verticality monitoring, process monitoring, sampling, testing, documenting, and meeting schedule milestones.
- e. Coring procedures, equipment, drillers resume, location, and frequencies.
- f. Wet grab soil-cement sampling procedures, equipment, locations and frequencies.
- g. Reporting procedures, forms and frequencies.

12.5-3.2.3 BINDER DELIVERY METHODS AND EQUIPMENT

Submit data on equipment such as mixers capable of producing a stable colloidal suspension of cement, bentonite slurry, or other mix combinations; storage facilities including tanks and methods of agitation; and delivery methods and equipment.

12.5-3.2.4 QUALIFICATION SUBMITTAL

Submit documentation supporting the requirements of QUALIFICATIONS. Resumes must include dates, durations, projects and owners.

12.5-3.2.5 SAMPLE QUALITY CONTROL RECORDS

Submit sample Quality Control Records. Include sample daily field reports, and laboratory test results.

12.5-3.2.6 HIGH PRESSURE OPERATING SAFETY PLAN

The Contractor is responsible for the safety of its personnel and equipment. The DMM Contractor must establish safety protocols and provide safety training to all personnel prior to ingress onto the site, as it relates to operating and working within the vicinity of high pressure pumps, lines, valves, grout plant, and DMM activities on the project site. A high pressure operating safety plan must be developed which contains the manufacture's names, telephone numbers and certificates relating to the safe operation of all pressure lines, valves, connections, blow-off valves, and any other items which operate under pressure (air or liquid). The manual will contain pump pressure characteristics used for the project, including pressure-flow-transmission setting curves for high pressure pump, and piston size. The manual will clearly identify the name, phone number, and location of Contractor-appointed high pressure safety officer. Each member of the DMM crew and all on-site personnel will sign the safety manual after receiving appropriate instruction. Any safety infractions and or incidences must be kept as a log entry in the safety manual. A copy of the manual must be available on site for review by the Government or their representative at all times. The safety manual must be submitted within 30 calendar days after the Notice to Proceed and mobilization of equipment must not proceed until approved by the Government.

The Contractor must establish and provide a plan in the safety manual covering the details of implementing a high pressure pumping safety corridor from the grout batch plant to their drill. The Contractor must show how their safety corridor will prevent any personnel or pedestrians from being exposed to the high pressure fluids used for DMM.

The Contractor must submit in the safety plan sketches, diagrams, and manufacturer's operating manuals on all safety valves used in controlling maximum pressure in DMM and waste conveyance lines. The Contractor must also provide a plan demonstrating the effectiveness of the safety valves and any required maintenance. Demonstration of each valves operation must be provided during the high pressure pump certification testing.

The Contractor must submit details of how operators at the drill rig will keep in constant communication with the high pressure pump operator. The Contractor must provide a communication system which will not solely rely upon handheld devices and provides a high level of assurance that high pressure pumping can be stopped quickly (i.e. 10 seconds or less).

12.5-3.2.7 SEQUENCE OF OPERATIONS AT UTILITY LINE CROSSINGS

Submit a proposed plan to accommodate utility crossing. This plan must be coordinated with the utility owner before submittal.

12.5-3.2.8 SAMPLING PLAN

Submit a description of the procedures which will be used to obtain wet samples at the various depths required. A detailed drawing and written explanation of how the sampling mechanism operates must be provided.

12.5-3.2.9 CUTOFF WALL SURCHARGE LOADING PLAN

Submit a description of all surcharge loads applied to the cutoff wall during cutoff wall construction. This plan must show the distance between all surcharge loads applied and the top of the cutoff wall during cutoff wall construction. This plan must include the surcharge loads from materials and equipment and must compare the loads against the strength of completed work. This plan must also include surcharge loads from materials and equipment at approved equipment crossing points. This plan must also include requirements for minimum cover and/or additional protective measures for the completed cutoff wall.

12.5-3.2.10 WORKING PLATFORM

Prepare the working platform to a firm and essentially level surface for passage of machinery and equipment to the elevation shown in the Plans. A berm, spoils trench or other appropriate type of barrier must be constructed within the construction limits to prevent off-site movement of waste materials, fluids, etc.

12.5-3.2.11 RIG ASSEMBLY

Assemble the rig in accordance with the approved Cutoff Wall Implementation Plan.

12.5-3.2.12 GROUT PLANT ASSEMBLY

Assemble the grout plant in accordance with the approved Cutoff Wall Implementation Plan. The grout plant may be located within the work area or at any of the staging areas.

12.5-3.2.13 RIG MOVEMENT TO WORK AREA

Move the rig to assembly area in accordance with all local and State standards with regarding to loading on roadways or bridges. Levee access roads may be used provided the equipment does not create an unstable ground condition.

12.5-3.3 MATERIAL DELIVERY AND INJECTION

12.5-3.3.1 DELIVERIES

Deliver material to the site on a timely basis so as not to impede production. Ensure that traffic areas are kept free in traffic in advance of deliveries to prevent delays in production.

12.5-3.3.2 SILO LOADING

Dry material must be stored in silos and fed to mixers for agitation and shearing. The air evacuated/displaced from the storage silos during the loading process must be filtered before being discharged to the atmosphere. In order to accurately control the water, bentonite, or cement mixing ratio, material mass must be weighed using the automatic batch scales in the mixing plant. Representative samples of the bentonite and cement must be obtained for each lot or truck load of material delivered to the site. These samples must be stored in airtight containers until the Contract is complete and must be used if needed, for testing to confirm material quality.

12.5-3.3.3 BATCHING, MIXING AND AGITATION

Minimum and maximum mixing time must be as established during the test element production. The specific gravity of the bentonite/cement slurry must be determined during the design mix program for confirmation of bentonite/cement slurry proportions.

12.5-3.3.4 PUMPING

Pumped grout from the plant must be monitored continuously by an automated data acquisition system and by the Grout Plant Operator during all operations.

12.5-3.3.5 AIR INJECTION

Air injection, if proposed, must be described in Contractor's Drilling and Invasive Program Plan specified under Section 12.2 EXISTING FACILITIES-SUBSURFACE DRILLING, SAMPLING, AND TESTING. The Drilling and Invasive Program Plan must demonstrate that the air injection will not have deleterious effects on levee integrity per ER 1110-1-1807. Drilling and Invasive Program Plan must be submitted, or updated and resubmitted for Government review and approval. The Government may allow use of air injection, not shallower than 10 feet below the working platform, in hard foundation layers below the embankment. Contractor must provide a submittal documenting, at a minimum, the equipment to be used, air pressure monitoring methods, and the Contractor's proposed air pressure limits and supporting calculations. The air pressure limits must be selected such that they do not cause hydrofracture of the levee embankment or foundation layers. If allowed, the Contractor must document the use of air injection in the Cutoff Wall Implementation Plan. Air pressure must be monitored through the use of gauges mounted on the air compressor lines and soil mixing rig. A cutoff wall element, or panel, must be restroked if there are any interruptions to the return air stream. Air injection must not be used during the withdrawal of drilling elements.

12.5-3.3.6 BENTONITE/CEMENT SLURRY INJECTION

12.5-3.3.6.1 LEADS

Inspect leads after each element, or panel, is constructed to verify correct operation.

12.5-3.3.6.2 PORTS

Inspect ports after each element, or panel, is constructed to verify correct operation.

12.5-3.4 EQUIPMENT

12.5-3.4.1 SOIL MIXING APPARATUS

The augers, bits, teeth, sheet plates or cutting heads for soil mixing equipment must be capable of thoroughly blending the in situ soils and bentonite/cement slurry to the design depths. Use the proper tooling for the apparatus, including but not limited to tooling capable of operating in clay (including hardpan), silt, sand, gravel, and cobbles. Change cutting teeth, shear plates, augers, etc. as necessary to allow

efficient advancement of the soil-mixing apparatus. Configure the equipment and/or element overlapping technique so that the length of the overlapping mixing elements extends for the full depth of the element and cutoff wall. The soil mixing method and apparatus must be sufficient to prevent soil inclusions greater than 3-inch maximum diameter from occurring within the element.

12.5-3.4.2 ELECTRONIC SENSORS

The preset data in the on-board computer must be verified as correct for each section of wall and, if necessary, adjusted (e.g., installation depth, bentonite/cement slurry amount ratio, advancement rate, etc.). The operator must monitor and adjust the soil mixing apparatus speed as necessary during the wall milling and mixing process. All metering equipment must be calibrated at the beginning of the cutoff wall installation work and again at the twenty-five percent project completion point, and every additional 25 percent increment (i.e., four calibrations during the project per rig). The soil mixing Contractor must submit the calibration results to the Contracting Officer.

The DMM rig must be equipped with electronic sensors built into the leads to determine vertical alignment in two orthogonal directions: fore-aft and left-right. The sensors must have a sensitivity of at least 1 part per 1000 (0.1 percent). The location of the sensors on the rig must be painted to be easily identified from the ground. The hardware utilized to determine panel verticality must be capable of measuring the deviation of one panel with respect to the adjacent panel at any incremental depth. The software accompanying the "inclinometer" hardware must be capable of graphically displaying the incremental and total accumulated deviations with depth / elevation and be coded to alert the reader to any excess deviations. The output from the sensors must be routed to a readout and data storage device and a display on the rig console that is visible to the operator and the Agency during penetration and withdrawal. The inclination of the augers must be continuously monitored and recorded. The recorded data must be available in table and graphic form such that the inclination and position of the as-built panel with respect to vertical and the adjacent panel can be easily determined.

12.5-3.4.3 PENETRATION DEPTH MARKING

The soil mixing equipment (e.g., kelly bar, mast, post, etc.) must be adequately marked to allow a visual determination that the correct depth of penetration has been reached.

12.5-3.4.4 CEMENT/BENTONITE SLURRY PLANT

Bentonite/Cement Slurry must be pre-mixed in a mixing plant, which combines dry materials and water in predetermined proportions. The mixing plant must consist of a bentonite/cement slurry mixer, agitator, pump, batching scales, and a computer control unit. Positive displacement pumps, or other suitable pumps as approved by the Contracting Officer must be used to transfer the slurry from the mixing plant to the soil-mixing apparatus. All aspects of the batching and pumping operations must be continuously monitored and recorded electronically. The batching and pumping record must be produced for each element.

12.5-3.4.5 REPLACEMENT PARTS

Maintain at the job site a supply of spare replacement parts and backup equipment sufficient to allow the soil-mixing cutoff wall construction to proceed without undue interruption due to mechanical breakdown or equipment failure.

12.5-3.5 INSTALLATION

12.5-3.5.1 DEMONSTRATION SECTION

A demonstration section is required before production work is permitted to proceed. Contractor must notify Corps at least fourteen (x14) calendar days prior to when the demonstration section will take place.

12.5-3.5.1.1 LOCATION

The demonstration section must be 60 linear feet of cutoff wall. The demonstration section must be located within the cutoff wall alignment at a location approved by the Government. The depth of cutoff wall in the demonstration section must be the same depth as the deepest part of the production cutoff wall. The Contractor must establish the cement and bentonite dosage and mixing index in the demonstration section.

12.5-3.5.1.2 MIX DESIGN DEVELOPMENT

Develop a laboratory testing program to demonstrate the adequacy of the proposed SCB mix design. The test materials must be taken from materials collected from at least three separate locations within the limits of the cut off wall; however, fabricate a sufficient number of samples and trial mix designs to support the basis for the proposed mix design. The trial mix designs must cover a range of percentages of bentonite, cement, and admixtures to correlate to the more granular anticipated ranges of soil gradations. The minimum number of mix designs must be four. The materials used to fabricate the test specimens must be those proposed for use in construction including foundation soil, bentonite, cement, water from the proposed project's source, admixtures, and any other materials. The soils used in the mix design must be representative of the full column of soils through which the cutoff wall will be constructed and must reflect the variability of conditions that will be encountered along the cutoff wall alignment. The performance criteria must include permeability and unconfined compressive strength in accordance with the parameters and methods of this specification. Provide a mix design, by both volume and weight, for each segment of the cutoff wall where the mix design is applicable.

The Cutoff Wall SCB Material Mix Design and SCB Mix Design Test Report must include the design of the SCB mix including the materials gradation and material sources, water sources, mix proportions, and design gradation ranges and the test sample gradations, slumps, densities, permeabilities, unconfined compressive strength, and moisture contents. The Cutoff Wall SCB Material Mix Design and SCB Mix Design Test Report must reflect the construction methodology proposed to perform the work. Submit results of at least three permeability and three unconfined compressive strength tests at each testing age (7, 14, and 28 days) of each final SCB mix using the SCB materials proposed, fully satisfying the performance criteria.

Provide adjustments to the mix design during construction to the Contracting Officer

before use, and document the location of each different mix on the as-built profile.

Submit the Demonstration Section Work Plan for approval a maximum of 60 calendar days from Contract award date. The work plan must be approved prior to the initial cutoff wall construction (Demonstration Section). The work plan must include: detailed description of equipment to be used in all sequences of DMM cutoff wall construction, procedures to be used during the project including, but not limited to, construction of cutoff wall and monitoring the quality control parameters, collecting samples from laboratory testing, and proposed mix design for DMM cutoff wall. The Demonstration Section Work Plan must reflect the methodology proposed to perform the work. Do not proceed with test element construction before Government acceptance of the demonstration section work plan.

12.5-3.5.1.3 ESTABLISHMENT OF MIXING INDEX

Prior to full scale production of the soil-mixed wall, construct a Demonstration Section to verify that the required permeability and strength can be achieved by the selected mix design, and that the installation methods provide adequate mixing, homogeneity, and continuity, for the existing field conditions at the project sites. The Demonstration Section may be incorporated into the permanent cutoff wall if it meets all the requirements for the production wall, subject to Government Approval. The Demonstration Section is to be used to determine the proportions of bentonite, cement, soil, water, slurry injection rate, soil-mixing apparatus rotation speed and penetration/withdraw or advancement rate (as applicable to method), and time delay between completion of a primary elements and beginning of an overlapping secondary element. Once established, these parameters will be used during installation of the production wall. Submit a revised Implementation Plan containing the selected mix design and established mixing index (I_m) which will be used for the project.

The mixing index for each method is as follows:

a. Wet Rotary Shaft (WRS)

$$I_m = M (N_p/V_p + N_w/V_w)$$

Where M is the total number of mixing blades, N_p and N_w are the rotational speed of axis during penetration and withdrawal in rev/min, and V_p and V_w are the velocity of the mixing apparatus penetration and withdrawal.

b. Wet Rotary End (WRE) and Wet Rotary and Jet End (WJE)

$$I_m = (N_p/V_p + N_w/V_w)$$

Where N_p and N_w are the rotational speed of axis during penetration and withdrawal in rev/min, and V_p and V_w are the velocity of the mixing apparatus penetration and withdrawal.

Wet Vertical Panel (WVP)

$$I_m = N_c(V_c/V_a)$$

Where N_c is the number of revolutions per minute of the cutting chain during advancement of 1 ft, V_c is the speed of the chain, and V_a is the advancement rate of the cutting head/rig.

12.5-3.5.1.4 CORE DRILLING AND TESTING

After 28 days (minimum) and before 56 days (maximum) of curing of the cutoff wall, perform four (4) vertical borings at locations selected by the Government. The borings will be drilled to an elevation not less than five (5) feet above the as-built invert elevation of the bottom of the cutoff wall at each respective location drilled. The borings must meet the following requirements.

- a. Drilling method: Perform coring of soil-cement in accordance with ASTM D2113 and the requirements stated herein. Use a large diameter triple tube, swivel type design core barrel, with a split inner tube. Adjust sampling methods or time of sampling to minimize disturbance and breakage of samples. Do not perform coring until the DMM mix strength is suitable for obtaining intact core samples. Protect core samples from drying.

The driller must operate his drill at such speeds and with such down pressures and must control drill fluid pressures and quantities to ensure maximum core quality and recovery in whatever hardness material is encountered. The driller must exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling, and other unusual and non-ordinary coring experiences that, supplementing the core record, could shed light on the nature and the extent of any abnormalities. The core drilling method is to be selected by the driller in accordance with the approved Demonstration Section Work Plan; however, as information, the following methods and drilling features have been used successfully in the coring of soil mix construction:

1. Experienced core drillers.
2. Wireline tools.
3. Triple tube coring equipment.
4. Diamond coring bit.
5. Side discharge bit.

- b. Core size: Use PQ core drilling size.

c. Core Recovery: If the core recovery is less than 85 percent for any core sample run, the corehole must be inspected with the specified borehole optical televiewer and the Government may direct the Contractor to perform supplemental coring at no additional cost.

d. Core Samples: Wash the retrieved cores and arrange them neatly in partitioned boxes in the same sequence they were retrieved from the hole. Label boxes clearly to designate date, time, depths, and location of core samples. Take a digital photograph of each core run clearly showing the labeled core box and the washed core, before sample preservation activities. When a box is full, fill the space between the core and the sides of the box with suitable packing materials.

Wrap the core samples designated by the ENGINEER for possible testing in thin plastic wrap to minimize moisture loss. Store core samples in a constant temperature, damp environment until tested. Place core samples into wax impregnated cardboard bore boxes with plastic wrap covering the cores prior to applying the top lid. Core boxes may be kept onsite until the end of the construction day and must be transported to a curing environment with controlled temperature and humidity by end of day.

Place marked spacer blocks in the core box to show where samples have been removed.

Retain core boxes containing untested samples until completion of DMM Wall construction. Upon final acceptance of DMM Wall construction by the Government, dispose of the cores.

Protect all core samples from direct sunlight, freezing and extreme weather conditions at all times.

e. Drilling fluid: Select A drilling fluid such as to maximize viewing of the inside of the bore hole with the optical televiewer probe. The Government evaluation will consider borehole viewing when approving or rejecting drilling fluids.

f. Drill rig positioning: Use surveying methods to position the drill rig at the test location selected by the Government. Position the drill core at the top surface of the cutoff wall to within one-tenth (0.1) of a foot horizontal of the proper location. After the drill rig has been properly positioned, proceed with boring

g. Borehole preparation: The borehole in the DMM wall must be sufficiently clean to provide a viewable surface given the optical televiewer characteristics. The borehole must be cleaned with a solution of five (5) percent sodium hypochlorite using water from a source previous approved by the Government. Clean the borehole before the downhole probe is run through the borehole.

Cleaning the hole with high pressure fluid jets exceeding twenty-five (25) pounds per square inch (psi) at the orifice is prohibited. Insufficient cleaning, as

indicated by the optical televiewer results, must be re-cleaned as directed by the Government.

h. Downhole probe: Use a downhole probe to survey all boreholes. The probe must measure, determine or display the following: borehole azimuth, incremental borehole deviation, borehole volume, borehole drift, true vertical depth, borehole diameter using caliper for both X and Y orthogonal directions, high resolution optical televiewer. The probe used must be the Robertson Geologging Inc. Borehole Optical Televiewer and Borehole Geometry Probe or approved equivalent.

i. Borehole optical televiewer: The borehole optical televiewer must meet the following minimum technical requirements:

- (1) Resolution (radial) equal to 360-1400 pixels (360°)
- (2) CMOS sensor 1280 x 1024 elements
- (3) Type: Digital Optical Borehole Televiewer
- (4) Frame rate: minimum 20HZ.
- (5) Exposure: 6.
- (6) Lighting: 10.
- (7) Resolution: 900 pixels.
- (8) Logging speed: 3 feet/minute maximum

j. Borehole probe: The borehole probe must meet the following technical requirements:

- (1) Caliper range 75 mm to 300 mm
- (2) Inclinator accuracy $\pm 0.25^\circ$
- (3) Azimuth accuracy $\pm 2.5^\circ$

k. In-Situ Permeability Testing: Conduct permeability tests at each borehole location as specified in Paragraph 12.5-3.5.1.6 IN-SITU PERMEABILITY TESTING. Measurements will be witnessed by the Government.

l. Borehole completion: Preserve and protect the borehole until directed to
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abandon the borehole by the Government. Grout boreholes from the bottom up using a cement-bentonite-grout mixture of six to eight gallons of water per sack (94 pound sack) of portland cement and 5% by dry weight of bentonite. Grout must be pumped through a tremie pipe that is inserted to the bottom of the hole to ensure that the grout fills the full extent of the hole.

Submit the work plan for all work proposed in this section in the Demonstration Section Work Plan. The borehole optical televiewer logging data must be submitted to the Contracting Officer and include a detailed and orientated 360° true color image of the borehole walls. The borehole probe survey must include plots of tabular and graphical outputs of borehole position, borehole drift and true vertical depth. The plotted data must include X-Y (horizontal movement vs. depth) and deviation bull's eye plot.

12.5-3.5.1.5 SPECIAL QUALITY CONTROL TESTING

A full suite of permeability and strength tests must be conducted on each mix design tested in the Demonstration Section. For each mix, perform in situ wet bulk sampling in the upper third, middle third and lower third of the cutoff wall and testing per Section 12.5-3.8.1. The selected mix design area will also be subject to the core testing per Section 12.5-3.5.1.4. To the maximum extent practical, the wet bulk samples are to be taken from the same panels to be cored.

12.5-3.5.1.6 IN-SITU PERMEABILITY TESTING

Permeability testing will be conducted in two stages of coring in an open hole, the first stage being above the water table and the second below the ground water table. Delineation of the start and stop point for each test must be based on the ground water table elevation measured at the nearest piezometer, relief well, or water well. All testing must be performed by Contractor's hydrogeologist and must proceed in accordance with the details provided by the Contractor in the Implementation Plan and Quality Control Plan as subsequently approved by the Contracting Officer. Provide raw test data and calculated permeability results to the Government.

- a. Constant Head and Falling head testing (Stage 1) must be performed within the corehole between the top of the SCB panel and within 1 foot of the ground water level.

Immediately prior to testing, the Contractor must pressure test the system equipment up to 100 psi gauge pressure to verify that there are zero leaks in the lines, fittings, and valves to be used in conducting this constant head water test.

The SCB cutoff wall material surrounding the corehole must be saturated by filling the corehole with water twenty-four (24) hours before performing the constant head/falling head test. The test itself must be eight hours in duration. To conduct the test, the corehole must be filled with water and pumped until filled to the top. The rate of pumping must be adjusted so as to maintain a near constant level of water in the top of the wall. After a steady state flow rate of pumped

water has been established, continue pumping for a minimum of 180 additional minutes, or until directed by the Field Representative. The water flow versus clock time must be recorded throughout pumping. Cumulative volume must be recorded periodically and at the conclusion of the test using a totalizing flowmeter.

Prior to shutting off the water pump, the Contractor must lower a troll pressure transducer (Insitu Level Troll 700 or approved equal) within the corehole to the bottom of the Stage 1. Use the troll to monitor the falling water level, water temperature, and elapsed time until the water level within the hole falls by at least 90% of the difference between the top of the casing and the ground water level.

The hydraulic conductivity of the soil-cement must be determined by the Contractor's hydrogeologist. The data reduction method must be by the methods for gravity permeability testing as described in the U.S. Bureau of Reclamation Engineering Geology Field Manual, Volume 2, Chapter 17

If the soil-cement in the cores for Stage 1 is well mixed and continuous and allows the core hole to stay open, then the Contractor must advance to Stage 2 coring and testing. If the soil-cement is poorly mixed and or the core hole does not remain open, the Contractor must stabilize the non-compliant zone using methods approved by the Contracting Officer and continue advancing the corehole to the second stage of testing. The approved method used to isolate the non-compliant zone must be sufficient in size and allow a minimum 4 inch-core to be extracted from the second stage of coring. The approved method must also allow insertion of all the in-hole tools for water testing to fit inside the entire length of the hole.

b. A water pump/rising head recovery test (Stage 2) must be performed for the portion of the corehole below the ground water table and to the bottom of the panel. The Stage 2 coring and testing must only proceed following proof that a compliant wall has been demonstrated with the Stage 1 testing. The Stage 2 coring must advance the Stage 1 core hole from the water table to within 5 feet of the bottom of cutoff wall. Measure and report the depth to the bottom of the borehole as drilled. Before starting the test, measure and report the depth to the bottom of the borehole again and the depth to the groundwater level.

A submersible pump must be set at the bottom of the corehole, and the pump will remove the slug of water from inside the hole to a depth of 10 feet above the elevation of the bottom of the corehole as originally drilled. The pressure troll (Insitu Level Troll 700 or approved equal) must then be lowered in the corehole to a position below the lowest water level. The borehole optical televiewer will be inserted into the corehole and slowly lowered to inspect the interior quality and consistency of the corehole under external water pressure. During the borehole televiewer monitoring (and after) the water level will be maintained by pumping to keep the water level depressed. Discharge volumes, water levels, temperature, and video footage will provide information on the soil-cement under large and

equipment, labor and materials in accordance with the submitted test plan as subsequently approved by the Contracting Officer.

Water flows, levels and temperature versus clock time must be recorded throughout pumping (drawdown) and natural recovery (rising head) using the pressure troll equipment with automated data logging and manual methods as a back-up. Cumulative volume must be recorded periodically using an automated volume totalizer. The duration of the test must be a minimum of 48 hours in continuous duration. At the end of the test measure and report the depth to the groundwater level.

The hydraulic conductivity of the soil-cement must be determined by the Contractor's hydrogeologist. The data reduction method must follow the Bower and Rice method, as adapted by Teeter and Clemence (ASCE 1986), and as detailed and submitted by the Contractor and approved by the Contracting Officer.

After all QA and QC evaluations has been performed, and results for both Stage 1 and Stage 2 have been approved by the Contracting Officer, the Contractor must tremie backfill the core hole starting

12.5-3.5.2 HEADING CONSTRUCTION

12.5-3.5.2.1 ELEMENT SEQUENCING

Element sequence must be proposed in the Demonstration Section Work Plan and implemented in construction of the cutoff wall. Deviations must be approved by the Government.

12.5-3.5.2.2 ELEMENT TO ELEMENT CONNECTIONS

Connect all vertical elements with a minimum 16-inch overlap (horizontally along the alignment of the cutoff wall), to ensure continuity to depth. For Horizontally installed Elements, the minimum horizontal overlap is three (3) feet.

12.5-3.5.2.3 PRODUCTION BREAKS

For elements with longer than 45 hours since installation of adjacent elements, double the overlap requirement. For Horizontally installed Elements, double the overlap to six (6) feet instead of three (3) feet.

12.5-3.5.2.4 HEADING CONNECTIONS

Headings are defined as new production walls of more than 3 elements. Connect new heading and old headings with a fifteen (15) foot long adjacent water side lap connection, if shown on the Drawings.

12.5-3.5.3 ELEMENT CONSTRUCTION

12.5-3.5.3.1 CONSTRUCTION STAKING

Provide, install, and maintain all temporary benchmarks, layout staking and necessary construction staking to locate the centerline of the wall. Survey construction control staking must be performed by a licensed Land Surveyor or Professional Civil Engineer. All survey data must be stamped by the Land Surveyor or Professional Civil Engineer.

12.5-3.5.3.2 RIG POSITIONING

The rig should be positioned by the Field Quality Control personnel to within one-tenth (0.1) foot of the surveyed locations.

12.5-3.5.3.3 PRE-DRILLING

Use pre-drilling as needed to achieve the required tie in elevation. Pre-drilling may be performed for the purposes of facilitating advancement of the soil mixing apparatus, or to facilitate blending the in situ soils. Predrilling costs must be included in the unit wall price.

12.5-3.5.3.4 MATERIAL MIXING

Establish a minimum and maximum mixing time during the test element production. The specific gravity of the bentonite/cement slurry must be determined during the design mix program for confirmation of bentonite/cement slurry proportions.

12.5-3.5.3.5 MIXING TECHNIQUE

The completed SCB element must be a homogeneous, uniform mixture of bentonite/cement slurry, and in situ soils. Soil and slurries must be mixed together in-place by mechanical mixing using the soil mixing apparatus for the full width and depth of the element. The cutting/mixing action must blend, circulate and knead the soil over the vertical height of the element and horizontal length of the element, as appropriate to the soil-mixing method.

For vertically installed elements, when the design depth is reached, the bottom 10 feet of each element must be remixed by raising the mixing shafts 10 feet and lowering them back down while continuing the mixing process. After restroking the element the mixing shafts must continue to mix at the bottom of the element for a minimum period of 1 minute. After completion of bottom remixing, the mixing shafts must be withdrawn while the slurry injection and mixing process is continued.

12.5-3.5.3.6 CONSTRUCTION PROGRESS

Installation of each element must be continuous without interruption. For vertically-installed elements or panel, if an interruption of more than 1 hour occurs, the element must be remixed for the entire height of the element using the correct dosage of fresh cement slurry. For horizontally-installed elements, if an interruption of more than 1 hour occurs, the interrupted element must be remixed by backing the apparatus over the interrupted length plus six (6) feet.

12.5-3.5.3.7 GROUT INJECTION RATE, SOIL MIXING APPARATUS ROTATION SPEED, AND PENETRATION/WITHDRAWAL RATES

The quantity of bentonite and cement slurry injected must be in accordance with the mix design established in the Demonstration Section. The slurry injection rate, soil mixing apparatus rotation speed, and penetration withdrawal rates must be constantly monitored, calculated, and controlled. For production quality control, real time monitoring of these parameters must be performed.

Variation of Injection Rate soil mixing apparatus rotation speed, and penetration/withdrawal rates for Vertically Installed Elements: If the injection rate, soil mixing apparatus rotation speed, and penetration /withdrawal rates vary for any measurement of the vertical element by more than ten (10) percent from the parameters established in the Demonstration Section, the Government may require additional testing and evaluation to determine the acceptability of the element. If the bulk injection volume of the grout for each element is greater than 10% below the mix design requirement, the vertical element must be remixed for the entire height of the element and the correct volume of grout injected to bring the element into compliance with the Demonstration Section parameters. If the bulk injection volume of the grout for each element is greater than 10% above

the mix design requirement, the element may be considered unacceptable, and the Contracting Officer may require additional testing to verify acceptability at no additional cost to the Government.

Variation of Injection Rate, Soil Mixing Apparatus Rotation Speed, and Penetration/Withdrawal Rates for Horizontally Installed Elements: If the bulk injection volumes of the grout, soil mixing apparatus rotation speed, and penetration/withdrawal rates for each element is less than required to meet the parameters established in the Demonstration Section, the horizontal element must be remixed for the entire length of the non-compliant grout injection section and the correct volume of grout added to bring the element in into compliance with the Demonstration Section parameters. If the bulk injection volume of the grout for each element is higher than required to meet the parameters established in the Demonstration Section the element may be considered unacceptable, and the Contracting Officer may require additional testing to verify acceptability at no additional cost to the Government.

Additionally, if movement of trench material in excess of typical movement observed on this project is observed in recently completed elements or panels, the Government may require the contractor to remix the area where the movement was observed and require additional testing to verify acceptable results at no additional cost to the Government.

12.5-3.5.3.8 BENTONITE/CEMENT SLURRY RATE MODIFICATION

Request to modify the established mix design and injection ratio if needed. All modifications are subject to Contracting Officer approval, and the Contracting Officer may require additional Quality Control testing to verify acceptable results at no

additional cost to the Government.

12.5-3.5.3.9 MIXING INDEX MODIFICATIONS

Request to modify the established mixing index if needed. All modifications are subject to Contracting Officer approval, and the Contracting Officer may request additional Quality Control testing to verify acceptable results at no additional cost to the Government

12.5-3.5.3.10 DEPTH MODIFICATIONS

The Contracting Officer may at any time direct changes to the wall depth to accommodate conditions encountered in the field. Provide sufficient equipment, including auger stem sections, mast or kelly bar lengths, or cutting posts (as applicable to the particular soil-mixing equipment) available at the site to extend the cutoff wall ten (10) feet deeper than the maximum depth shown on the plans.

12.5-3.6 SPOIL MATERIAL

Provide positive means for containing all spoil return, flush water and other waste materials within the immediate work area. Pipe or channel spoils material into holding ponds, tanks, or other retention structures or facilities. Implement measures to prevent any spoil return, other waste materials, or stockpiled materials from entering adjacent water bodies or from leaving the site via surface runoff. In the event spoil return, waste materials, or stockpiled materials enter an area or facility outside the approved work area or mixing spoils storage area, the Contractor must be responsible for immediately notifying the Contracting Officer and completely cleaning and removing these materials, at no additional cost to the Government.

12.5-3.7 DEMOBILIZATION

12.5-3.7.1 CLEANUP

The Contractor must continually clean up wastes, debris and leftover materials resulting from the cutoff wall construction process. After completion of the work, the site must be cleared of all debris that may have accumulated in the execution of the work. Dispose of all waste materials in accordance with all Federal, State, and local regulations and codes, such as the Clean Water Act and the National Historic Preservation Act.

12.5-3.7.2 DISPOSAL OF WASTE MATERIALS

Dispose of spoil generated by the cutoff wall construction and materials that contain cement, off-site as the property of the Contractor, in accordance with all Federal, State of California, and local regulations and codes, such as the Clean Water Act and the National Historic Preservation Act. The cost for all disposal of waste generated from the cutoff wall soil-mixing process must be included in the unit cost for the cutoff wall. All fill used on site must meet the requirements of these Special Provisions to the Caltrans Standard Specification Section 19 Earthwork. Waste material must be stockpiled separately from active fill areas and must be disposed of off-site on a minimum bi-weekly basis.

12.5-3.7.3 SURVEY MONUMENTS

Place G Series Drive-in Piston Survey Monuments at the centerline of the levee, to mark each end of the cutoff wall (total of 2 monuments). Survey the ends of the cutoff wall using a California licensed surveyor before levee restoration (to stamp on the monuments as approved by the Government) within one-tenth (0.1) foot (vertical and horizontal) then place on centerline of levee after levee restoration.

12.5-3.8 FIELD QUALITY CONTROL

Establish a Quality Control Program during the pre-construction period. The requirements include a materials testing component and a field quality control component. The established Quality Control Program will remain in effect through the duration of the Contract. The quality control program must include that all QC testing be performed by a US Army Corps of Engineers Materials Testing Center (MTC) approved laboratory.

12.5-3.8.1 MATERIALS TESTING

12.5-3.8.1.1 SAMPLE COLLECTION AND TESTING

Wet bulk sampling and testing is required as indicated below. Sampling frequencies for the Demonstration Section are higher as indicated below. Acceptance of the work will depend on demonstrating that the in-place wall is homogeneous, continuous, and has achieved the permeability and strength requirements. The Government may conduct additional quality assurance sample collection and testing, in addition to the required testing. Collect samples using: (1) discrete wet bulk sampling at frequencies described below, and (2) other sampling methods as required to obtain representative samples of construction materials. Results of tests performed on wet bulk samples must take precedence over results of other sampling methods.

12.5-3.8.1.2 GROUT TESTING

Check the specific gravity of the grout at least twice per shift per rig in accordance with ASTM D4380. Report the specific gravity measurements on the Daily Quality Control Reports.

12.5-3.8.1.3 WET BULK SAMPLES

Wet bulk material must be sampled and test cylinders prepared per ASTM D4832, with the following exceptions. Each cylinder must be 3 inches in diameter and 6 inches in length. The wet bulk sample must be taken using a device that allows for complete retrieval of the mixed material from a specified depth without additional mixing or segregation. The device used to retrieve the wet grab soil-cement samples must be capable of obtaining a discrete fluid sample of soil-cement at a pre-determined depth and must be capable of accepting lumps of soils not thoroughly mixed that are up to 6 inches in dimension. Once filled with the soil-cement the sampler must be closed to exclude entry or loss of soil-cement and be expeditiously raised to ground surface. One wet bulk sample must be obtained for every 50 linear feet of cutoff wall constructed. The sample depth must vary. One third of the total number of samples must come from the upper zone of the wall. One third of the total number of samples must come from the middle zone of the wall. One third of the total number of samples must come from the bottom zone of the wall. The retrieved samples must be passed through a ¾-inch sieve prior to cylinder fabrication, no other

sieving is allowed. Material retained by the ¾-inch sieve must be discarded from the sample. After the sample is retrieved from the wall additional mixing of the sample is prohibited. Releasing agents such as WD-40, cooking sprays, or other hydrophobic agents may not be used within test cylinders cast for cutoff wall testing. Perform 7, 14, and 28-day unconfined compressive strength and 7, 14, and 28 day permeability tests for each sample. The 28-day test results will be evaluated for acceptance. For each wet bulk sample collected, fabricate a minimum of two (2) extra cylinders for possible additional "backup" testing. Retrieve the soil-cement samples and prepare all test cylinders within 60 minutes of the withdrawal of the mixing equipment from the soil-cement element.

Submit twelve (12) sets of wet bulk samples from the Demonstration Section. Samples must be taken from elements that represent one of the mix designs selected by the Contracting Officer for Government quality assurance testing. Four (4) sets of cylinder samples must be prepared at three (3) depths representing the upper one third, middle one third, and lower one third of the cutoff wall. To the maximum extent practical, the wet bulk samples are to be taken from the same panels to be cored.

Up to approximately 20 percent of the Wet Bulk Sample test locations may be selected for quality assurance testing by the Government. Quality assurance testing locations will be selected by the Contracting Officer. Obtain and provide to the Contracting Officer a set of eight representative cylinders for quality assurance testing along with Chain of Custody Form for Quality Assurance Samples.

12.5-3.8.1.4 LABORATORY PERMEABILITY TESTING

Laboratory permeability testing must be in accordance with ASTM D5084, with the following modifications. Attempt to saturate the specimen using back-pressure saturation. Perform back pressure saturation concurrently with consolidation by applying cell and back pressures in accordance with the table below. Check the B coefficient at the completion of each saturation/consolidation stage. If the B coefficient is greater than or equal to 0.9 after the completion of consolidation at Stage 4 pressures, perform permeability testing. If the B coefficient is less than 0.9, increase pressures to the next stage and measure the B coefficient after waiting a minimum of 2 hours. If a B coefficient of 0.9 or greater is not attained at Stage 6, note on the test report that a B coefficient of 0.9 could not be achieved and perform permeability testing.

Stage	Cell Pressure (PSI)	Back Pressure (PSI)	Effective Confining Pressure (PSI)
1	5	3	2
2	10	8	2
3	20	15	5
4	30	20	10
5	40	30	10

Stage	Cell Pressure (PSI)	Back Pressure (PSI)	Effective Confining Pressure (PSI)
6	60	50	10

The initial gradient used during permeation must be 20. Plots of the ratio inflow to outflow, gradient, and permeability versus time must be required for each test. Lines describing the boundary limits for the listed termination criteria must be included on the plots. The permeate liquid must be clean water. The specimen top cap, bottom cap, and porous end pieces must have a diameter equal to the diameter of the test specimen ± 2 percent. Head must be increased on the inflow end at the bottom of the specimen to a pressure which will develop the gradient of twenty (20).

12.5-3.8.1.5 STRENGTH TESTING

Laboratory strength testing must be in accordance with ASTM D4832. In addition, strength test data reports must include photographs of each failed sample.

12.5-3.8.1.6 CONTINUITY

Continuity of the cutoff wall must be confirmed by a) constructing the panels with an overlap, and b) measuring and recording the verticality of the machine leads during the forming of the wall. The maximum incremental deviation (deviation with respect to the position of the adjacent panel) at any depth must not be greater than twenty (20) percent of the specified minimum wall thickness. The accumulated total deviation of any single panel from vertical must not exceed one (1) percent of the panel depth.

12.5-3.8.1.7 LABORATORY TESTING

An independent validated testing laboratory (current ASTM and USACE certifications), that is Material Testing Center approved, and approved by Contracting Officer, must perform the Contractor's laboratory testing including hydraulic conductivity and unconfined compressive tests. The independent Quality Control testing laboratory selected by the Contractor must submit detailed laboratory testing reports including information relating to equipment used for testing.

12.5-3.8.2 RIG INSTRUMENT AND TELEMETRY

12.5-3.8.2.1 INSTALLATION RECORDS

Installation records per element must include: date, location, element ID, shaft spacing, rpm calibration, depth calibration, speed calibration, batch plant calibration, pump calibrations, verticality calibrations, start and finish times, top and bottom elevations, unusual circumstances and changes, depth, elapsed time, and speed, rotation, bentonite/cement slurry injection rate and volume, energy, and torque versus depth.

electronically, in Excel, or equivalent, format.

12.5-3.8.2.2 MIXING TECHNIQUE

The completed SCB element must be a homogeneous, uniform mixture of bentonite/cement slurry and in situ soils. Soil and slurries must be mixed together in-place by mechanical mixing using the soil mixing apparatus for the full width and depth of the element. The cutting/mixing action must blend, circulate and knead the soil over the vertical height of the element and horizontal length of the element, as appropriate to the soil-mixing method.

12.5-3.8.2.3 WALL CONTINUITY

Construct the cutoff wall such that the wall is continuous from each respective starting and ending point indicated on the Plans. No gaps between elements leaving unmixed soil are permitted for the entire length and full depth of the cutoff wall.

12.5-3.8.2.4 SOIL MIXING APPARATUS ROTATION SPEED AND PENETRATION AND WITHDRAWAL RATES

Establish the soil-mixing apparatus rotational speed and penetration/withdrawal/advancement rates during the test section, and adjust as needed to achieve adequate mixing. If the rotation speed and penetration and withdrawal or advancement rates vary by more than ten percent from the parameter established in the test section, the Contracting Officer may require additional testing to verify acceptable results at no additional cost to the Government. Refer to paragraph 12.5-3.5.3.7, Grout Injection Rate, for additional requirements.

12.5-3.8.2.5 BENTONITE/CEMENT SLURRY INJECTION RATE

The quantity of bentonite/cement slurry injected must be in accordance with the mix design established during the test section. The slurry injection rate must be constantly monitored, calculated, and controlled. For production quality control, real time monitoring of the slurry injection rate must be performed. If the injection rate varies by more than ten percent from the parameter established in the test section, the Contracting Officer may require additional testing to verify acceptable results at no additional cost to the Government.

12.5-3.8.2.6 MODIFICATIONS TO INJECTION RATE

Request to modify the established mix design and injection ratio as needed. All modifications are subject to Contracting Officer approval, and the Contracting Officer may request additional Quality Control testing to verify acceptable results at no additional cost to the Government.

12.5-3.8.2.7 CONTINUOUS REAL TIME MONITORING AND RECORDING OF

THE FOLLOWING SOIL MIXING PARAMETERS

The following parameters must be recorded and stored at one second intervals:

- a. Penetration Rate of Lead(s) or Cutting Head.
- b. Continuous panel position versus depth to enable continuous verification of panel verticality at all depths of advancement
- c. Rotation Speed of Auger, Cutter Heads, Cutting Chain
- d. Rig advancement speed, if applicable.
- e. Bentonite/Cement Slurry Injection Rate.
 - i. Measured at grout plant.
 - ii. Measured at rig.

12.5-3.8.3 REPORTING

12.5-3.8.3.1 MATERIALS TESTING

- a. Weekly Reporting: Submit weekly reports of materials testing, including summary tables of results for all tests completed thus far.
- b. Final Reports: Submit a final of materials testing, including summary tables of results for all tests completed thus far.

12.5-3.8.3.2 DAILY REPORTS

The Daily Field Quality Control Reports must include:

- a. Report of Daily Production

Construction Records are reports, documentation, test results, logs, and material certificates. Construction records must be submitted for the cutoff wall test section and all subsequent production work no less than two working days after completion of each shift. All information must be submitted in electronic format and hard copy. Data and test summaries must be in Microsoft Excel files. Text reports must be in Microsoft Word

- b. Rig Operators Log.
- c. Grout Plant Operators Log.
- d. Field Quality Control Engineer's Log.
- e. Rig Instrumentation Records.

1. Identification of Area of Work.
2. Rig number.
3. Date and time (start and finish) of element installation.
4. Panel number and reference drawing number.
5. Panel top and bottom depths or elevations.
6. Plot of panel verticality versus depth for each panel.
7. Grout injection volume.
8. Slurry specific gravity measurements.
9. Test methods and results.
10. Description of obstructions, interruptions, or other difficulties encountered during installation and how they were resolved.
11. Soil-mixing apparatus rotation speed per 3-foot vertical interval versus depth.
12. Penetration and withdrawal rates in feet per minute versus depth.
13. Slurry injection rate and pressure at the soil-mixing apparatus at every 3-foot vertical interval versus depth.
14. Other pertinent observations including, but not limited to, description of spoil returns, grout escapes, ground settlement and/or heave, collapses of the element, remixing of elements, obstructions, and any unusual behavior of the equipment during the soil mixing process.

f. Grout Plant Records.

1. Batching Records by both volume and weight of all components.
2. Slurry Density.
3. Grout Density.
4. Pumping Volume (Durations, Rate).

g. Results of Calibration Tests

Submit Calibration Results within 7 days of the test.

h. Results of Slurry or Grout testing

Submit results with Daily Field Quality Control Report.

i. Shipping Tickets

Submit results with Daily Field Quality Control Report.

j. Products Certifications

Submit for approval as-built Plans and end-of-construction Summary Report prepared by a Professional Civil Engineer and a licensed Land Surveyor indicating the width, depth, and location of the cutoff wall in terms of project coordinates, all quality control and quality acceptance test results, all pertinent submittals, mix designs used, subsurface conditions encountered, major problems, core logs, and all construction equipment. The summary report must summarize and compare statistically all test data to the contract requirements. An As-Built Profile of Cutoff Wall and End of Construction Summary Report must be submitted.

12.5-3.9 PROTECTION OF CUTOFF WALL

The cutoff working platform must have backfill material placed to the lines and grades shown on the Plans. No construction activity on top of the cutoff wall will be permitted until the initial set of the backfill has occurred. Take all necessary actions to protect the cutoff wall from disturbance and prevent the drying of the top of the cutoff wall.

A temporary soil cap of non-compacted soil (Soil Type 1) is to cover the top of the wall above the working surface with height and width as shown on the Drawings and is to be placed within 24 to 48 hours after cutoff wall placement in a manner that does not impose any equipment load on the cutoff wall.

Heavy construction equipment and machinery must only be driven over the cutoff wall at approved equipment crossing points which are "bridged" with steel plates and additional cover material and transmit no loads to the cutoff wall.

After a minimum of four (4) days of curing under the temporary soil cap or when the cutoff wall has reached a minimum unconfined compressive strength of 15 psi, whichever is greater in time duration, the temporary soil cap must be removed and impervious levee fill must be placed and compacted as shown on the Plans and as specified in the Special Provisions for the Caltrans Standard Specification Section 19 Earthwork.

12.6 PAYMENT

Levee embankment fill (soil type 1) will be measured for payment by the cubic yard and quantities will be determined by the lines and grades shown on the plans to the nearest cubic yard. Levee embankment fill (soil type 1) placed outside the dimensions shown on the plans will not be included in the measurement for payment. Volumes occupied by structures will not be included in the measurement for payment.

Bid price shall constitute full compensation for furnishing all labor, equipment and material, and performing all operations necessary to complete the work, including but not limited to foundation preparation, stockpiling, excavation at borrow source(s), hauling to and from project sites, placing and compacting the material, materials testing, surveying, and moisture control. No separate payment will be made for providing material from borrow source(s), preparing and/or restoring borrow sites, excavation at borrow source(s), stockpiling, blending and moisture conditioning, hauling material to and from the borrow source(s) and the project site, or any other work necessary to provide levee embankment fill as outlined in the Project Plans and Specifications.

Payment for levee cut-off wall shall be at the unit price bid per square feet of wall measured in a vertical plane through the centerline of the cutoff wall as established by the working surface indicated on the Plans, and the bottom of the cutoff wall and vertical lines at each end of the cutoff wall. Measurement shall be based on surveys and measurements taken at the site as directed and reviewed by the Owner. Payment shall be made on the basis of a wall constructed to the depth indicated on the Plans unless installation to a greater depth is directed by the Engineer.

Bid price shall include the provision to extend the wall an additional 10 feet in accordance with these Special provisions, with no increase in unit bid price. Such price shall constitute full compensation for furnishing all labor, material, equipment, and incidentals and performing all operations necessary to complete the Work specified herein including performing at a minimum of four subsurface explorations along the cutoff wall alignment; performing laboratory testing to develop DMM mix design; excavation of cutoff trench; performance of demonstration section; hauling and disposing of DMM spoils offsite; providing backfill materials from excavations at borrow areas and/or obtaining materials from commercial sources; mixing, blending, and pumping; temporary cap installation and removal including excavation; surveying; quality control and quality acceptance testing; reporting; preparing as-built information; and all other items incidental to the construction and completion of the cutoff wall as shown or specified in these special provisions. No separate payment will be made for materials including bentonite, cement, additives, soil, equipment and mixing, handling and cleaning the slurry, and overtime during continuous operations, cleanup, assistance in the collection and maintenance of records and quality control testing; such items being included in the price of the cutoff wall construction.