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MAIN WASTEWATER TREATMENT PLANT OXYGEN PLANT REHABILITATION (SD-428)

♦

CONTRACT DOCUMENTS

VOLUME II-A OF IV

TECHNICAL SPECIFICATIONS (DIVISIONS 02-26)

JUNE 2024

SPECIFICATION SD-428

EAST BAY MUNICIPAL UTILITY DISTRICT
SPECIAL DISTRICT NO. 1
OAKLAND, CALIFORNIA

Bids will be opened at 1:30 pm, Wednesday, September 11, 2024 in the Board Room, Second Floor of the District's Administration Building, 375 11th Street, Oakland, California

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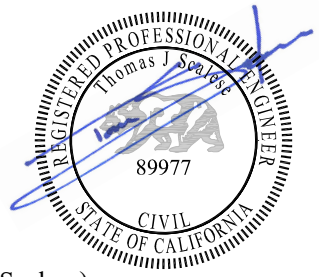
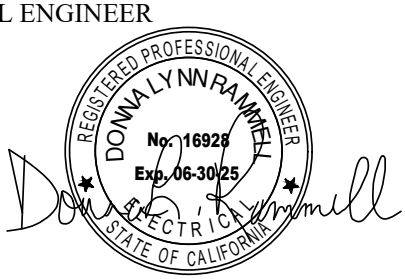
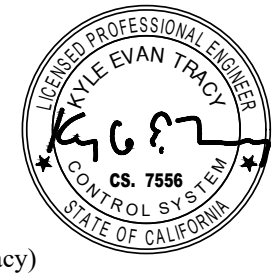
EAST BAY MUNICIPAL UTILITY DISTRICT
SPECIAL DISTRICT NO. 1
OAKLAND, CALIFORNIA

SECTION 00 01 07

PROFESSIONAL SEALS AND CERTIFICATIONS

GENERAL

The following design professionals have signed and sealed the original specifications for this project in accordance with the List of Specification Sections.

CIVIL ENGINEER  Dave Richardson (D. Richardson) Woodard & Curran California License: 37097	CIVIL ENGINEER  Thomas Scalese (T. Scalese) Woodard & Curran California License: 89977
ELECTRICAL ENGINEER  Donna Rammell (D. Rammell) Woodard & Curran California License: E16928	CONTROLS ENGINEER  Kyle Tracy (K. Tracy) Woodard & Curran California License: C7556
CIVIL ENGINEER  John Law (J. Law) East Bay Municipal Utility District California License: 95046	FIRE PROTECTION ENGINEER  Christian Ng (C. Ng) Fire & Risk Alliance, California License: 2132

SPECIFICATION SECTION AND TITLE	DESIGN PROFESSIONAL SEAL BY
DIVISION 00 – PROCURMENT AND CONTRACTING DOCUMENTS - ALL SECTIONS	D. Richardson
DIVISION 01 – GENERAL REQUIREMENTS – ALL SECTIONS	D. Richardson
DIVISION 02 - EXISTING CONDITIONS – ALL SECTIONS	D. Richardson
DIVISION 03 – CONCRETE – ALL SECTIONS	T. Scalese
DIVISION 05 – METALS – ALL SECTIONS	T. Scalese
DIVISION 07 – THERMAL AND MOISTURE INSULATION – ALL SECTIONS	D. Richardson
DIVISION 09 – FINISHES – ALL SECTIONS	J. Law
DIVISION 21 – FIRE SUPPRESSION – ALL SECTIONS	C. Ng
DIVISION 22 – PLUMBING	
22 05 00 Air Compressor Motors	D. Richardson
22 05 29 Hangers and Supports for Plumbing Piping and Equipment, 22 05 53.05 Pipe Identification, 22 11 16 Domestic Water Piping, 22 11 19 Domestic Water Piping Specialties	J. Law
DIVISION 26 – ELECTRICAL – ALL SECTIONS	D. Rammell
DIVISION 27 – COMMUNICATIONS – ALL SECTIONS	K. Tracy
DIVISION 28 – ELECTRONIC SAFETY AND SECURITY – ALL SECTIONS	C. Ng
DIVISION 40 – PROCESS INTEGRATION – ALL SECTIONS	K. Tracy

END OF SECTION

SPECIFICATION SD-428

MAIN WASTEWATER TREATMENT PLANT OXYGEN PLANT REHABILITATION

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VOLUME II-A – TECHNICAL SPECIFICATIONS (DIVISIONS 02 THROUGH 26)

END OF SECTION

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes: Perform selective demolition including removal and disposal of mechanical equipment, instruments, valves, and electrical components and other work as shown on the drawings and as specified herein.

B. Acquire demolition permits and follow all requirements.

C. Related sections:

1. Document 00 31 24 – Materials Assessment Information
2. Section 01 32 00 – Construction Progress Documentation
3. Section 01 35 13 – Special Project Procedures
4. Section 01 35 24 – Project Safety Requirements
5. Section 01 35 44 – Environmental Requirements
6. Section 02 83 13 – Lead Hazard Control Activities
7. NOT USED.

1.2 JOB CONDITIONS

A. Asbestos-related work and hazardous substance removal work shall be performed by Contractor who is properly certified by the Contractors State License Board and registered with the Division of Occupational Safety and Health.

B. Promptly repair damages caused to adjacent facilities by demolition operations at no cost to the District.

C. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

D. Provide interior and exterior shoring, bracing, and support to prevent movement, settlement or collapse of structures and adjacent facilities to remain.

E. See Document 00 31 24 – Materials Assessment Information for existing hazardous substances.

F. Blasting is not permitted.

1.3 SUBMITTALS

A. Submit Construction and Demolition Waste Disposal Plan in accordance with Section 01 35 44.

B. Submit demolition plan showing schedule of phased demolition, as part of and consistent with the progress schedule specified in Section 01 32 00, hazard control methods, plans to stabilize structure while not in the active stages of demolition, and method of demolition proposed at each site.

C. Submit plan on methods and materials to be used to protect operating equipment during demolition operations for the Engineer's approval.

D. Shop drawings: Proposed shoring plans stamped by a Civil Engineer registered in the State of California.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Demolition operations shall be conducted in accordance with Article 31 of the Construction Safety Orders, Title 8, California Code of Regulations.

B. Conduct demolition operations and removal of debris to ensure minimum interference with roads, walks, and other adjacent occupied or in-use facilities to remain as shown on the drawings.

C. Ensure safe passage of persons around area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities, and persons.

D. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt dispersion. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations.

E. Remove, handle, and dispose of off-site, in a safe, appropriate, and lawful manner, and in accordance with Site Safety and Health Plan, all materials and equipment that are required to be removed under this contract.

3.2 PREPARATION

A. Utilities:

1. Notify District or appropriate utilities to turn off affected services before starting demolition.

2. Remove utility lines exposed by demolition excavation.

3.3 NOT USED.

1. NOT USED.

3.4 EQUIPMENT PROTECTION

A. Oxygen Production Building:

1. Temporary equipment enclosures shall be constructed around new and existing MCC, instrument panels, control panels, pumps, and motors to protect the equipment during equipment demolition and construction. Each enclosure shall be constructed of 3/4" (min.) thick exterior grade plywood, and shall be weather-tight, free standing, and provide physical protection from falling debris of weight no less than 100 pounds. Use methods to minimize debris near the intake of operating equipment including but not limited to Main Air Compressors, control panels, and MCCs.

2. Provide pump and motor enclosures with the following features:

a. Stationary, weather-tight, air louvers on each side of pump motor for ventilation. Provide a minimum total free louver area of at least 1 square foot per louver.

b. Coordinate with the Engineer to maintain clearance between the equipment motor and the interior surface of the enclosure to avoid damage to the equipment (i.e. vibration, heat) and maintain accessibility.

3. Provide MCC, instrument panel, and control panel enclosures with the following features:

a. Double or single, full height (7'-6" min.) hinged access doors for each MCC.

b. Double or single, full height (7'-6" min.) hinged access doors for each instrument panel.

c. Double or single, full height (7'-6" min.) hinged access doors for each control panel.

d. Securely anchor enclosure to floor slab and wall with threaded drop-in anchor bolts set 1/2" min. below concrete surface.

e. Provide 6-inch minimum clearance between all enclosure panel surfaces and interior surface of enclosure.

4. Remove all temporary enclosures as required during installation of other equipment. Grout all anchor bolt voids with non-shrink grout.

3.5 DEMOLITION

A. Drawings define minimum portions of structures, facilities, and equipment to be removed. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.

B. Remove material from existing improvements as required to permit connection of new work. Avoid both damage to the portion to remain, and interference with the use and operation of existing structures and utilities.

1. Pavement to be removed shall be saw cut to a uniform line prior to removal.

2. Shut off, cap, or otherwise protect existing public utility lines in accordance with the requirements of the public agency or utility having jurisdiction.

3. Completely remove all materials designated for removal as shown on the drawings.

C. Remove piping from areas to be backfilled. Pipe, valves, and fittings adjacent to those to be removed may also be removed as salvage.

D. Remove all materials associated with existing equipment that is to be removed or relocated.

E. Cut off concealed or embedded piping, conduit, boxes, reinforcing steel, anchor bolts, or other materials a minimum of 3/4" below the final finished surface.

F. Patch existing surfaces to create a neat, smooth appearance. Use non-shrink grout to patch concrete or masonry surfaces. Use like materials for other surfaces.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove, handle, and dispose of off-site, in a safe, appropriate and lawful manner, and in accordance with Section 01 35 44, all materials that are required to be removed under this contract.

B. Underground conduits, pipes, and drainage facilities that are to be demolished shall be removed flush with any excavation and a 0.5 foot thick plug of concrete placed securely in the pipe end to provide closure.

C. Burning of removed materials is not permitted on the site.

END OF SECTION

SECTION 02 42 05

DEMOLITION AND SALVAGE

PART 1 - GENERAL

1.1 GENERAL

A. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor as required for the demolition and removal of structures, and facilities as indicated on the drawings and as specified herein.
The work of this section shall include, but shall not be limited to, the following items:

1. Clearing, grubbing, stripping and removal and disposal of top soil and vegetation.

2. Demolition of asphalt pavement, concrete pads, and curb and gutter and other features as required and backfilling of the resulting voids.

3. Removal and salvage of existing facilities and equipment as indicated on the drawings and specified.

4. Demolition of existing structures.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. The scheduling of all work specified herein shall conform to the requirements of

1. Section 01 35 13 - Special Project Procedures

2. Section 01 35 24 – Project Safety Requirements

3. Section 01 35 44 – Environmental Requirements

1.3 DEMOLITION COORDINATION

A. The Contractor shall carefully coordinate the extent of demolition in areas where existing utility services shall be disconnected and reconnected to new facilities, where existing facilities shall remain operational, and where vegetation and curb and gutter shall be restored.

B. In the case of existing utilities where only a portion is to be demolished, the Contractor shall cap or seal the utility at the point of disconnection such that the remainder of the system can remain in service.

C. In the case of existing ductwork or piping where a portion will be demolished followed by future connection to new construction, the Contractor shall cleanly cut the duct or pipe and promptly cap it to protect it during construction.

D. Existing ductwork, filters, registers, air handling units and heat pumps taken out of service by such demolition work shall be cleaned and reconditioned by the Contractor prior to being put back into service.

1.4 SUBMITTALS

A. Demolition procedures shall be submitted to the Engineer for acceptance. The procedures shall provide for safe conduct of the work, careful removal and disposition of materials and equipment, protection of facilities and property which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operation.

1.5 REPAIR OF DAMAGE

A. Any damage to personal property, and to other existing facilities to remain, as caused by the Contractor's operations shall be repaired at the Contractor's expense.

B. Damaged items shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to or better than that existing prior to damage or start of work of this contract.

1.6 BURNING

A. The use of burning at the project site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations will not be permitted.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 DEMOLITION

A. Disposal of all materials shall be performed in compliance with all applicable local, state and federal codes, and requirements.

B. Asphalt concrete pavement, concrete pavement and concrete curb and gutter shall be removed as necessary to perform the specified work. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt pavement, concrete pavement and concrete curb and gutter shall be constructed as specified and shown.

3.2 SALVAGE

A. Unless specifically identified in the Contract Documents, when existing structures, equipment, or pipelines are removed, they shall be the property of the Contractor. Materials shall be disposed of properly off-site by the Contractor at the Contractor's cost.

END OF SECTION

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SECTION 02 83 13

LEAD HAZARD CONTROL ACTIVITIES

PART 1 - GENERAL

1.1 COMPLIANCE AND INTENT

A. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits, and agreements necessary to perform the lead removal in accordance with these specifications and with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Air Quality Management District with authority over the project, the Cal/EPA Department of Toxic Substance Control, the California Occupational Safety and Health Administration (Cal/OSHA), and other federal, state, county, and local agencies. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.

B. Comply with proposed regulations for Title 8 CCR Section 1532.1 for Lead in Construction, which shall be in effect starting on January 1, 2025. This will replace the original standard from 1978. A copy of the proposed regulations can be found on the Department of Industrial Relations website and is also available at: https://www.dir.ca.gov/oshsb/documents/Lead-proptxt.pdf

1. A summary of expected changes to the new lead rulings can be found here: https://www.cal-osha.com/flash-report/cal-osha-finally-gets-the-lead-proposal-out/. Some of the major changes include:

   a. Reduction of the permissible exposure limit (PEL) from 50 micrograms of lead per cubic meter (µg/m3) to 10 µg/m3. Workers exposed to lead above the PEL shall wear a protective suit, use a respirator, and take an on-site shower after exposure.

   b. Reduction of the action level from 30 µg/m3 to 2 µg/m3. Activities required when workers exposed to lead above the action level include: Action Level training for workers, additional air sampling, and blood lead level monitoring.

   c. Establishing additional hygiene practices such as hand washing and shower stations.

   d. Mandating a lower blood lead level at which medical removal protection from lead work is required.

C. During demolition procedures, the Contractor shall protect against contamination of soils, water, adjacent buildings and properties, and the airborne release of hazardous materials and dusts. The costs associated with the implementation of controls will be incurred by the Contractor.

D. Any information developed from exploratory work done by the District and any investigation done by the Contractor to acquaint himself with available information will not relieve the Contractor from the responsibility of properly estimating the difficulty or cost of successfully performing the work. The District is not responsible for any conclusions or interpretations made by the Contractor based on the information made available by the District or District's representative.

E. Hazardous materials uncovered during the demolition activities shall be disposed of in an approved manner complying with all applicable federal, state, and local regulations. Appropriate waste manifests shall be furnished to the Engineer as per Section 01 35 44, Environmental Requirements. Materials are conveyed to the Contractor "as is," without any warranty, expressed or implied, including but not limited to, any warranty to marketability or fitness for a particular purpose, or any purpose.

1.2 SCOPE OF WORK

A. The work covered by this specification includes the handling, removal, and proper disposal of lead-containing coating as required as a result of the work at Main Wastewater Treatment Plant Oxygen Production Facility. See Appendix B for laboratory test results of interior coating samples, including lead and other hazardous constituents.

B. The Contractor shall perform all work according to the procedures outlined in these specifications.

C. The hazardous materials removal and disposal include the following:

1. Properly remove and dispose of all lead-containing material as part of the coatings related work.

1.3 RELATED WORK IN OTHER SECTIONS

A. Section 01 35 24 – Project Safety Requirements

B. Section 01 35 44 – Environmental Requirements

C. Section 01 35 53 – Security Procedures

1.4 SUBMITTALS (PRE-JOB)

A. Site safety plan: The Contractor shall provide a site safety plan prior to project initiation as specified in Section 01 35 24.

B. Lead Demolition Plan: Lead-containing coating handling, engineering control, removal, and disposal procedures.

C. Cal/OSHA Lead Work Pre-Job Notification, if required.

D. Submittal of worker documentation for employees used on the job.

1. Lead-Containing Coating Demolition Work: All Contractor's supervisors and workers performing lead-containing coating work shall meet the requirements of the California Department of Health Services (DHS) lead-related construction interim certification (17 CCR 350001).

E. Licenses: Submit copies of state and local licenses and evidence of Cal-OSHA certification and permits necessary to perform the work of this contract.

F. Submit name and Environmental Laboratory Accreditation Program Certificate number of laboratory that will test samples collected during air monitoring. See Article 3.2 below.

1.5 SUBMITTALS (JOB IN PROGRESS)

A. The Contractor shall provide to the Engineer test results of air sampling described in Specification 09 90 00.

1.6 SUBMITTALS (POST-JOB)

A. Upon completion of on-site work, Contractor is to provide a detailed project summary which will include each of the items listed below. The project Summary shall be submitted and approved by the Engineer prior to contract acceptance and shall include the following:

1. Receipt and weight tickets from the landfill operator acknowledging the Contractor's delivery of wastes and including dates of delivery, waste container types, quantities, tared weight of waste delivered, and all appropriate signatures.

2. All completed waste manifests; and copies of all accident reports during the course of the project.

PART 2 - MATERIALS AND EQUIPMENT

2.1 SIGNS AND LABELS

A. Provide labeling in accordance with U.S. EPA requirements. Provide the required signs, labels, warnings, or posted instructions for containers used to transport contaminated material to the landfill.

B. Location of Caution Signs and Labels: Provide bilingual caution signs at all approaches to work area. Locate signs at such a distance that personnel may read them and take the necessary protective steps required before entering the area.

C. Warning Sign Format: Vertical format conforming to Title 8 CCR Section 1532.1:

WARNING

LEAD WORK AREA
POISON
NO SMOKING OR EATING

2.2 SCAFFOLDING

A. Scaffolding, as required to do the specified work, shall meet all applicable safety regulations and OSHA standards. A non-skid surface shall be furnished on all scaffold surfaces subject to foot traffic.

2.3 TRANSPORTATION EQUIPMENT

A. Transportation equipment, as required, shall be lockable and suitable for loading, temporary storage, transit and unloading of waste without exposure to persons or property. Any vehicle used to transport waste shall be properly registered with all applicable controlling agencies.

PART 3 - EXECUTION

3.1 INITIAL AREA ISOLATION (LEAD)

A. Establish designated limits for the lead work area with continuous barriers. Use caution tape for lead work. Provide signs around the perimeter of the work area according to EPA, OSHA and Cal-OSHA requirements.

B. Contractor shall secure the entire job site at all times. Area entrances and exits shall be secured by the Contractor during the abatement phase. Unauthorized visitors are strictly prohibited, only the Contractor and District's representatives are permitted at the job site. Contractor shall ensure that all doors, gates, windows, and potential entrances in the buildings and surrounding fences are secured and locked at the end of each work day. See also Site Access Control in Section 01 35 53 Security Procedures.

3.2 AIR MONITORING - LEAD

A. The purpose of any air monitoring conducted by the Engineer will be to detect possible release of dusts (lead) emanating from the work area. This testing will be conducted independently of the air monitoring described in Section 01 35 24.

B. The Contractor shall be responsible for all personal air sampling. During the performance of any work in the contaminated work area that is likely to create airborne lead exposure, sufficient personnel breathing zone samples shall be taken to constitute representative sampling. These samples shall be taken each shift and for each distinct crew operation, and shall be used to verify adequacy of respiratory protection. Personal breathing zone air sampling shall be in accordance with CAL/OSHA lead standards.

3.3 DECONTAMINATION - LEAD

A. Lead Decontamination: The Contractor shall remove all evidence of coating chips from the jobsite that are related to the project demolition.

END OF SECTION

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SECTION 03 01 30.61

RESURFACING OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Resurfacing of existing concrete surfaces. This section shall apply to areas identified on the Drawings requiring "resurfacing" or "resurfacing mortar." Contractor shall determine quantities of materials required for this work and shall include all costs for resurfacing of concrete in bid item 1. Assume an average additional thickness of no less than ½ inch thick resurfacing mortar on all surfaces in addition to any added thickness called out on drawings.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

ASTM C 109	Test Method for Compressive Strength of Hydraulic Cement Mortars – Modified
ASTM C 348	Test Method for Flexural Strength of Hydraulic Cement Mortars
ASTM C 469	Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C 882	Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete – Modified
ASTM C 1202	Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Penetration

B. International Concrete Repair Institute

ICRI 210.3R	Guide to Using In-situ tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials
ICRI 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
ICRI 310.2R	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing resurfacing concrete materials and including storage instructions, installation instructions and MSDS sheets.

C. Manufacturer's Mixing and Application Instructions.

D. Application Equipment: List and describe all equipment proposed for the work with written certification that the equipment is in good condition for the intended service and in conformance with requirements of ACI 504R for wet mix application.

E. References of applicators and manufacturers approval for quality control per paragraph 1.4.

F. Manufacturer’s certification of surface preparation per Paragraph 3.1 I.

G. Independent Testing Engineer, concrete tensile pull-off test plan and certified test results per paragraph 3.6.

1.4 QUALITY ASSURANCE

A. Applicator

1. Three years of experience applying similar product as specified. Submit three references that the Contractor has demonstrated successful application of the specified product within the past two years. Provide name, address and telephone number of the Owner for each application.

2. Applicator shall be approved by the mortar manufacturer.

B. The Contractor shall comply with the requirements of ACI 506R including but not limited to the crew qualifications and quality control.

C. Manufacturer shall attend a pre-installation meeting and make periodic visits to the project site to provide inspection services and consultation during surface preparation and application of coatings. Manufacturer shall inspect the surface preparation, the equipment being used for and the procedures of application by the Contractor and shall submit written certification that the work is in accordance with the manufacturer’s recommendations.

D. Manufacturer Qualifications: The manufacturer of the specified resurfacing mortar shall have been in existence, for a minimum of 10 years.

E. Allowable Tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10 foot straight edge.

F. Contractor's equipment to pump the concrete resurfacing mortar shall not be older than 10 years from the date of manufacture. Rebuilt pumps will not be accepted. Contractor shall provide equipment serial number for verification.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the Manufacturer.

C. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground and suitably protected.

1.6 SITE CONDITIONS

A. Apply resurfacing mortar between 50 and 95 degrees Fahrenheit.

B. Turn off forced ventilation and radiant heating systems and protect work against drafts during installation and minimum 72 hours after completion. Use indirect auxiliary heaters to maintain temperature in area. Vent temporary heaters to exterior.

C. Follow manufacturer's recommendations regarding additional installation information (hot weather-drying conditions, or cold weather installation).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Resurfacing Mortar: Sprayable, trowelable, shrinkage-compensated, one-component with silica fume, fiber reinforced, cementitious structural mortar with integral corrosion inhibitor, suitable for vertical and overhead applications. It must be compatible with proposed repair mortar (if different).

1. Compressive Strength: ASTM C109

a. 1-day: 3,500 psi min.

b. 28-day: 8,000 psi min.

2. Splitting Tensile Strength: ASTM C496

a. 7-day: 350 psi min.

b. 28-day: 735 psi min.

3. Flexural Strength: ASTM C348

a. 7-day: 650 psi min.

b. 28-day: 1100 psi min.

4. Chloride Permeability: ASTM C1202

a. 28 day: < 1000 coulombs

5. Sulfate Resistance: ASTM C1012

a. 6 months: < 0.10%, or 1 year: < 0.06%

6. Direct Tensile Bond Strength: ACI 503R, Appendix A

a. 7-day: 175 psi min.

b. 28-day: 300 psi min.

7. Modules of Elasticity: ASTM C469

a. 28-day: 3.5 to 5 million psi

8. Color: Concrete grey.

9. Manufacturers: One of the following or equal:

a. Sika Corporation, Lyndhurst, NJ, “SikaRepair 224”, 1(800)933-7452

b. Sika Corporation, Lyndhurst, NJ, “SikaCem -226 CI”, 1(800)933-7452

c. Master Builders Solutions, Shakopee, MN, “MasterEmaco S 488CI”, 1(800)433-9517.

d. Or approved equal.

e. Or approved equal.

B. Curing Compounds: As recommended by Manufacturer and water based in accordance with ASTM C-309.

C. Finishing Aid/Evaporation Retarder: As recommended by the Manufacturer.

1. Master Builders Solutions, MasterKure ER50.

2. Sika, SikaFilm.

D. Water: Potable.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. General: Perform surface preparation in compliance with ICRI Technical Guide 310.1R "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion."

B. Saw-cut perimeter of the area to be repaired to a minimum depth of 1/2". Do not cut existing steel reinforcement. Verify the existing conditions of entire perimeter prior to beginning saw-cutting.

C. Remove all unsound or deteriorated concrete, dirt, oil, grease, any existing coatings, and all other bond-inhibiting materials from the areas to be resurfaced. Remove a minimum depth of existing concrete as indicated on drawings (based on the original finished surface when new), but no less than 1-inch, and continue removal as required to expose sound aggregate and achieve minimum amplitude. Preparation work shall be done by high, or ultra-high pressure water blast, scabbler, or other appropriate mechanical means to obtain an exposed aggregate surface with a minimum surface profile indicated below. Saturate the surface with clean water.

D. Substrate shall have minimum amplitude of ¼-inch. Limit the size of chipping hammers to 15 lbs to reduce micro fractures.

E. Roughness of surface shall be not less than Concrete Surface Profile (CSP) 6 as defined by International Concrete Repair Institute (ICRI 310.2R).

F. Substrate shall be saturated surface dry (SSD) with no standing water during application.

G. Where reinforcing steel with active corrosion is encountered, inspect and repair the reinforcing steel per Section 03 01 30.62, CONCRETE REPAIR.

H. Thoroughly clean the roughened surface and exposed reinforcement of rust, dirt, loose chips, and dust using high pressure water.

I. The Contractor shall not dispose of sediments from concrete surface preparation to the Wastewater Treatment Plant. These sediments shall be disposed of in accordance with the Construction and Demolition Waste Disposal Plan per Section 01 35 44, ENVIRONMENTAL REQUIREMENTS.

J. Manufacturer's Certification: Following surface preparation and prior to application of the resurfacing mortar, the manufacturer's representative shall inspect the surface preparation and submit written certification that the work is in accordance with the manufacturer's recommendations.

3.2 MIXING

A. Comply with mortar manufacturer's recommendations for water quantity and mixing procedures.

3.3 APPLICATION

A. Apply resurfacing mortar by low-pressure wet spray or hand-trowel to thickness indicated on drawings. Drawing thickness is based on the original finished surface when new. Actual applied thickness will be greater.

B. Apply mortar in accordance with manufacturer's instructions.

C. Use flat edge steel trowel.

D. Do not fill or cover existing expansion and control joints with mortar. Replace joint material to match and connect with the existing adjacent joints.

3.4 FINISHING

A. Level surface of mortar using a float or screed.

B. Apply final finish when mortar has begun to stiffen.

C. Provide smooth steel trowel finish (S3) for walls and underside of roof slab and non-skid finish (S4) for top of roof slab and floor slab.

1. S3 Finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.

2. S4 Finish: Steel trowel finish, without local depressions or high points, followed by light hair broom finish. Do not use stiff bristle brooms or brushes. Broom parallel to slab-drainage. Provide resulting finish that is non-skid and acceptable by the Engineer.

3. For surfaces to be coated:

a. Coordinate finish with the coating manufacturer's requirements.

b. Finished surface shall not have any reinforcing fibers protruding that may impact the performance of the coating.

3.5 CURING

A. Protect fresh mortar from premature evaporation. Cure finished resurfacing mortar immediately after finishing by one or both of the following methods as recommended by Manufacturer and in compliance with ACI – 308R recommendations for Portland cement concrete.

1. Keep area continuously moist with fine mist of water as soon as mortar surface has hardened (thumb print hard), for a minimum of three days.

2. Apply curing compound as recommended by Manufacturer and in accordance with ASTM C-309. Curing compound shall only be allowed for the top coat of the resurfacing material. Solvent based curing compounds shall not be allowed.

B. Protect newly applied material from direct sunlight, wind, rain and frost. Include protective tents as required to prevent sunlight from hitting all newly placed material for a minimum of 7 days after placement.

C. Do not use curing compound for mortar surface that will receive epoxy coating, or remove the curing compound prior to coating.

3.6 FIELD TESTING

A. Contractor shall employ an Independent Testing Engineer to perform in-situ tensile pull-off tests witnessed by the District Inspector to verify:

1. Surface soundness of the existing concrete.

2. Adhesion of mortar to the existing concrete surface.

3. Tensile strength of mortar.

B. Tests shall be made per the manufacturer's recommendations and requirements of ICRI Guideline No. 210.3R.

1. Samples shall be core drilled to a minimum either 1 inch depth or one-half of core diameter, whichever is greater, into the existing substrate prior to testing. Do not cut existing reinforcing steel.

2. Mortar shall be cured for a minimum 14 days prior to testing.

3. Pull-off required Strengths: 200 psi min. on substrate; 175 psi min. on mortar and bonding to substrate. No tests below 75% of the required strength.

C. Numbers and Locations of Test

1. Surface Soundness Test:

a. Two (2) tests for each 300 linear feet of channel walls.

b. Two (2) tests on underside of channel roof for each 300 linear feet.

2. Adhesion and mortar tensile strength Tests:

a. Two (2) tests for each 300 linear feet of channel walls.

b. Two (2) tests on underside of channel roof each 300 linear feet.

3. Locations of test shall be determined in field by Engineer.

D. Retest

1. Retest per ICRI Guideline when the average strength of test results is below the strength requirement or the test result of any single test is below 75% of the required strength.

2. Cost of retests shall be paid by Contractor.

3. Cost of retesting the substrate, that meets surface profile and preparation requirements as set forth in this Section, shall be paid by District.

E. Submit certified test results to District.

F. Repair

1. Make any repairs as needed when retest results fail to meet acceptance criteria.

2. Retest after repair. Repairs and retests shall be no additional cost to District.

3. The existing substrate shall be repaired as directed by Engineer. If surface profile and preparation meets requirements as set forth in this Section, cost of such repair shall be paid by District.

3.7 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

SECTION 03 01 30.62

CONCRETE REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Repairing damaged structural concrete including, but not limited to, cracks 1/8 inch wide and larger, spalled areas and unsound concrete surfaces.

B. Related Sections:

1. Section 03 01 30.61 – Resurfacing of Cast-in-Place Concrete

2. Section 03 20 00 – Concrete Reinforcement

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 546-14 Guide to Concrete Repair

2. ACI 548.13-14 Specification for Bonding Fresh Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive

3. ACI 562-16 Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures

B. American Society for Testing and Materials (ASTM) publications for standard test methods including: C 78, C 109, C 348, C 496, C 882 and C1202.

C. International Concrete Repair Institute (ICRI):

1. 310.1R – 2008 Guideline for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion

2. 320.1R – 2019 Guideline for Selecting Application Methods for the Repair of Concrete Surfaces

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer of the specified product shall have been in existence, for a minimum of ten (10) years.

B. Applicator Qualifications: Minimum of three (3) years of experience applying similar product as specified and approval of the mortar manufacturer.

C. Allowable Tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10 foot straight edge

1.4 SYSTEM DESCRIPTION

A. General: Structural repair concrete product(s) composed of cementitious materials and other admixtures capable of being placed in formed or unformed vertical and overhead applications, as well as on horizontal and all other sloped surfaces.

B. Design Requirements:

1. For inside tanks and channels: Suitable for performing in environments subject to corrosive attack by chlorides, sulfates and other wastewater constituents. Properties shall include low permeability, low-shrink and abrasion resistant.

2. Provide repair mortars for either hand application or formed (pump or pour) application.

3. Include mortars that can be placed in depths from 1/8 inch and extendable to greater depths.

4. Compatible with resurfacing mortar, per Section 03 01 30.61, when applied in, or adjacent to, areas that will be resurfaced.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing structural repair concrete materials and including storage instructions, installation instructions and MSDS sheets.

C. Certified Estimate of Quantity of Work: Prior to performing the concrete repair work under this Section, inspect areas designated for repairs to verify the quantities of concrete to be repaired. Spray paint limits of work for each area to be repaired and number each location. Submit a summary report indicating the area number, location, description and estimated quantity. The District shall review and agree upon the total quantity prior to the start of work at each area.

D. Certificates of Compliance for quality assurance per Paragraph 1.3.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the Manufacturer.

C. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground and suitably protected.

1.7 PROJECT CONDITIONS

A. Hot Weather: ACI 305.

B. Cold Weather: ACI 306.

C. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.

PART 2 - PRODUCTS

2.1 REPAIR MORTAR SYSTEM

A. Repair Mortar – Inside Tanks and Channels

1. Compressive Strength: As follows in accordance with ASTM C 109:

a. 1 day: 3,500 psi, minimum.

b. 7 day: 6,600 psi, minimum.

c. 28 day: 9,000 psi, minimum.

2. Slant Shear Bond Strength: 2,500 psi minimum at 28 days, in accordance with ASTM C 882 Modified.

3. Splitting Tensile Strength: 735 psi minimum at 28 days, in accordance with ASTM C 496.

4. Flexural Strength: 1,100 psi minimum at 28 days, in accordance with ASTM C 348.

5. Chloride Permeability: ASTM C1202

a. 28 day < 500 coulombs

6. Color: Concrete grey.

7. Manufacturers: One of the following or equal:

a. Master Builders Solutions, Shakopee, MN, “MasterEmaco S 488CI”, 1(800)433-9517

b. Sika Corporation, Lyndhurst, NJ, “SikaRepair 224”, 1(800)933-7452

8. Repair mortar shall be extended with course aggregates per manufacturer's recommendation for repair of thick section.

B. Repair Mortar Hand Applied - Outside Tanks and Channels

1. One-component, trowel-able or pourable, high strength with low permeability, structural repair mortar with integral corrosion inhibitor, suitable for vertical repairs.

a. Compressive Strength: In accordance with ASTM C 109:

1) 1 day: 2,500 psi, minimum.

2) 28 day: 7,500 psi, minimum.

b. Slant Shear Bond Strength: 1,800 psi minimum at 28 days, in accordance with ASTM C 882 Modified.

c. Splitting Tensile Strength: 550 psi minimum at 28 days, in accordance with ASTM C 496.

d. Flexural Strength: 770 psi minimum at 28 days, in accordance with ASTM C 348.

e. Color: Match adjacent concrete.

f. Extendable with coarse aggregates per manufacturer's recommendation for repair of thick section.

g. Manufacturers: One of the following or equal:

1) Master Builders Solutions, Shakopee, MN, "MasterEmaco S 466CI".

2) Sika Corporation, Lyndhurst, NJ, "SikaRepair 223".

C. Repair Mortar Formed – Outside Tanks and Channels

1. Pump and pourable repair mortar. Cement based, high early strength, abrasion resistant, with integral corrosion inhibitor.

a. Compressive Strength: In accordance with ASTM C 109:

1) 1 day: 2,000 psi, minimum.

2) 28 day: 6,500 psi, minimum.

b. Slant Shear Bond Strength: 2,500 psi minimum at 28 days, in accordance with ASTM C 882 Modified.

c. Splitting Tensile Strength: 950 psi minimum at 28 days, in accordance with ASTM C 496.

d. Color: Match adjacent concrete.

e. Manufacturers: One of the following or equal:

1) Master Builders Solutions, Shakopee, MN, "MasterEmaco S 477CI".

2) Sika Corporation, Lyndhurst, NJ, "Sikacrete 211 SCC Plus".

D. Surface Repair Mortar – Minor cosmetic repairs outside Tanks and Channels

1. Polymer-modified, cement based, fast-setting, non-sag mortar with integral corrosion inhibitor, suitable for vertical and overhead applications.

a. Compressive Strength: In accordance with ASTM C 109:

1) 1 day: 2,000 psi, minimum.

2) 28 day: 6,000 psi, minimum.

b. Slant Shear Bond Strength: 2,100 psi minimum at 28 days, in accordance with ASTM C 882 Modified.

c. Splitting Tensile Strength: 550 psi minimum at 28 days, in accordance with ASTM C 496.

d. Color: Match adjacent concrete.

e. Manufacturers: One of the following or equal:

1) Master Builders Solutions, Shakopee, MN, "MasterEmaco N 300 CI".

2) Sika Corporation, Lyndhurst, NJ, "SikaTop 123 Plus".

E. Anti-corrosion coating for reinforcing steel:

1. Manufacturers: One of the following or equal:

a. Master Builders Solutions, Shakopee, MN, "MasterEmaco P 124".

b. Sika Corporation, Lyndhurst, NJ, "Sika Armatec 110 EpoCem".

F. Epoxy Bonding Agent:

1. Compatible with repair mortar. Compatibility shall be approved in writing by the repair mortar manufacturer.

2. Manufacturers: One of the following or equal:

   a. Sika Corporation, Lyndhurst, NJ, "Sikadur 32, Hi-Mod or Sikadur 32, Hi-Mod LPL".

   b. Master Builders Solutions, Shakopee, MN, "MasterEmaco ADH 1090 RS or MasterEmaco ADH 326".

G. Finishing Aid:

1. Compatible with repair mortar. Compatibility shall be approved by repair mortar manufacturer.

2. Manufacturers: One of the following or equal:

   a. Sika Corporation, Lyndhurst, NJ, "SikaFilm".

   b. Master Builders Solutions, Shakopee, MN, "MasterKure ER50".

H. Water: Potable, clean, not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare estimate of quantities as required under Submittals prior to performing concrete repairs.

B. Verify that concrete surfaces and exposed reinforcing are clean and free of contaminates.

3.2 PREPARATION

A. Remove all loose and deteriorated concrete, cleaning with steel brush.

B. Roughen and clean surfaces to receive product in accordance with manufacturer's recommendations and ICRI (minimum surface profile on concrete of +/- 1/8 inch.).

C. Thoroughly clean reinforcement and other embedded items to remove loose rust and other objectionable matter.

D. Thoroughly wet wood forms, except coated plywood, and adjacent concrete at least one hour in advance of placing mortar as recommended by manufacturer; securely close cleanout end inspection ports; repeat wetting as necessary to keep forms damp.

E. Damaged Concrete:

1. Areas to be repaired shall be clean, sound, and free of contaminants. Saw cut perimeter 1/2 inch minimum. Do not cut existing reinforcing steel unless indicated on Drawings. Remove all loose and deteriorated concrete by mechanical means acceptable to the Engineer.

2. Chip concrete substrate to obtain an exposed aggregate surface with a minimum construction surface profile of CSP-5 or CSP- 6 in accordance with manufacturer's print instructions. The area to be repaired shall be not less than one inch in depth.

3. Concrete removal shall extend along the reinforcing steel to locations along the bar that are free of bond inhibiting corrosion, and a minimum distance of 3 inches beyond where the bar is well bonded to surrounding concrete.

F. Use the following procedures where reinforcing steel with active corrosion is encountered:

1. Abrasive blast to remove all rust, scale and contaminants from the exposed reinforcing bar and achieve all prepared surfaces as recommended by anti-corrosion coating manufacturer.

2. If more than half the diameter of the reinforcing bar is exposed, chip out all around the bar a minimum of 1/2 inch. The clearance chipped around the reinforcing bar must also equal or exceed the minimum placement depth of the accepted repair mortar.

3. Inspect and determine section loss due to corrosion. Replace corroded reinforcing bar with a new bar of the same size where corrosion has depleted cross-section area by more than 15 percent. Splice new reinforcing bar to the existing bar or install dowels per details on the Drawings or as directed by the Engineer.

4. Coat all exposed reinforcing steel surfaces after they are prepared with anti-corrosion coating as recommended by manufacturer. Apply coating the same day after abrasive blasting. If flash rusting of the metal occurs before coating, re-blasting will be required.

G. Treat cracks in the substrate at the area of patching or overlay work as directed by the Engineer.

H. Restore (and if necessary extend) any existing control and/or expansion joints that occur through any concrete repair areas.

I. Apply bonding agent in accordance with manufacturer's instructions to entire repair area prior to application of the repair mortar.

3.3 MIXING

A. Mix in accordance with manufacturer's mixing instructions.

B. Provide a mixture of white and regular cements as required to make a mortar that after curing 28 days will match adjacent concrete. When a mix has been selected for color match, batch all mortar by weight in accordance with the formula for the selected mix.

3.4 INSTALLATION

A. Maintain substrate in a saturated, surface dry condition.

B. For hand applications, a bond slurry coat is required.

C. Apply repair mortar by low-pressure wet spraying or hand-troweling on vertical or overhead surfaces in depths ranging from 3/8” to 2”.

1. Vertical Applications: Do not exceed 2” thickness per lift.

2. Overhead Applications: Do not exceed 1.5” thickness on first pass. For depths greater than 1.5”, limit succeeding lifts to 1” thickness.

3. Multiple Passes: Place succeeding lifts after repair mortar has developed initial set. Scarify the surface of the first lift to ensure integral bond between successive layers.

D. Install in accordance with manufacturer’s installation instructions.

E. In accordance with ACI recommendations, apply concrete repair material only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing.

F. Scrub mortar into substrate, filling all cracks, voids, and pores.

G. Level surface of repair mortar using a float or screed.

H. Apply final finishing aid when mortar has begun to stiffen using a wooden, plastic, or synthetic sponge float.

I. For new construction, finish of repaired area shall match required finish for concrete being repaired. For existing concrete, finish of repair area shall match existing finish of concrete being repaired.

J. Cure per manufacturer’s recommendations. During the curing process, protect concrete repair from direct sunlight, rain, wind, or freezing as required. Keep sufficient covering on hand at all times for protection of repair concrete.

3.5 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

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SECTION 03 11 00

CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

A. Work included: Furnish and install formwork for cast-in-place concrete.

B. Related Sections:

1. Section 03 30 00 – Cast-in-Place Concrete

2. Section 03 35 00 – Concrete Finishing.

1.2 QUALITY ASSURANCE

A. Design Criteria:

1. Formwork, including forms, falsework, shoring, bracing, and accessories such as ties, anchors and hangers, shall be designed in accordance with Chapter 1 of ACI 347 - American Concrete Institute Standard Recommended Practice for Concrete Formwork.

2. The design and construction of forms and form supports shall be subject to approval of the Engineer, but responsibility for their adequacy shall rest with the Contractor.

B. Tolerances:

1. Formwork shall be constructed and maintained as required to produce completed work within the tolerance limits specified in Chapter 2 of ACI 347.

2. The following construction tolerances are hereby established and apply to finished walls and slabs unless otherwise shown:

Item	Tolerance
Variation of constructed linear outline from the established position in plan.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2 inch
Variation from the level or from the grades shown.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	Plus 1/2 inch, Minus 1/4-inch
Variation in the location and sizes of slabs and wall openings	Plus or minus 1/4-inch

C. Source Quality Control

1. Forms: Verify that components pre-assembled offsite are satisfactory for the purpose. Verify, that designs, products and samples have been submitted for Product Review.

1.3 SUBMITTALS

A. Submit detailed plans of the falsework proposed to be used to the Engineer for acceptance. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Submit prior to start of work.

B. Submit literature for the Engineer's approval on:

1. Forms, if fabricated off construction site

2. Metal forms

3. Form ties or through-bolts

4. Form coatings and Release Agent.

1.4 JOB CONDITIONS

A. Falsework and vertical shoring:

1. Design, construction, inspection, and removal of falsework and vertical shoring shall be in full conformance with the provisions of Section 1717 of the Construction Safety Orders, Title 8, California Code of Regulations.

2. All falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet shall be approved and signed by a civil engineer, registered in the State of California.

3. A copy of the approved falsework plan or shoring layout shall be available on the job site at all times.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Plywood for forms shall be Plyform Class I, B-B EXT-APA, conforming to the specifications of the U. S. Department of Commerce Voluntary Product Standard PS-1 requirements.

B. Metal forms may be used on approval of the Engineer.

C. Alternate form materials, such as hard bond fiberglass or steel, may be used to provide an F3 finish (See Section 03 35 00 – Concrete Finishing).

D. Form ties:

1. Form ties shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and to permit ready removal of the forms without spalling or damaging the concrete.

2. Space ties at uniform intervals across surface; align in horizontal and vertical directions.

3. Do not use wire ties or wood spreaders of any type.

4. Provide form ties of such design that when forms are removed, they leave no metal or other material within 1-1/2 inches of the surface of the concrete.

5. No form-tying device or part thereof other than metal shall be left imbedded in the concrete.

6. Cone-snap ties:

a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-1/2 inches deep and all such fasteners shall be such as to leave holes of regular shape.

b. Provide neoprene Waterseal washer that is located near the center of the concrete.

7. Taper ties:

a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs re located in center third of wall thickness.

E. Form Release Agent:

1. When required to prevent bond, forms shall be treated with an approved compound which is not deleterious to concrete and which will not cause discoloration of the finished surface.

2. Use a resin base form release agent on forms for concrete to be painted.

F. Falsework and shoring:

1. Falsework and forms shall be constructed to produce in the finished work the lines and grades indicated on the drawings.

a. Suitable jacks, wedges, or camber strips shall be used in connection with falsework to set the forms to the required grade or camber and to take up

any settlement in the formwork either before or during the placing of concrete.

b. Falsework shall be formed upon solid footing safe against undermining and protected from softening.

2. Manufactured shores of adjustable type shall not be used if wear, damage, or defects make them incapable of supporting the loads for which they were designed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form all cast-in-place concrete unless specified otherwise.

B. Surfaces of all forms in contact with concrete shall be clean, rigid, tight, and smooth unless otherwise specified.

C. Reusable forms shall be of such a type that they can be entirely removed and remain watertight upon reuse.

3.2 CONSTRUCTION OF FORMS

A. Form panels that are attached directly to the studding or joists, shall be not less than 5/8-inch thick, and the studding or joists shall be placed not more than 12 inches center-to-center.

B. Form panels less than 5/8-inch thick, otherwise conforming to the requirements specified in this section, may be used with a continuous backing of surfaced material 3/4-inch thick.

C. Form panels more than 5/8-inch thick attached to studding or joists spaced at more than 12 inches center-to-center may be used, provided that deflection of the panel between studding or joists does not exceed that of a 5/8-inch panel attached to studding or joists spaced at 12 inches center-to-center.

D. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar defects in the finished concrete exceeding the allowable irregularities for the formed finishes specified.

E. Exposed edges on the outside and inside of structures shall be chamfered with triangular fillets 3/4" by 3/4", unless otherwise noted on the drawings or ordered by the Engineer.

F. Provide for temporary openings for cleaning out, observation, pouring and vibration of concrete.

G. Where forms for continuous surfaces are placed in successive units, the forms shall fit tightly over the completed surface so as to prevent leakage of mortar from the concrete and to maintain accurate alignment of the surface.

H. Provide tight seams, or seal with tape, to be mortar-tight.

I. Reset forms shall overlap the hardened concrete with sufficient tie bolts so as to prevent loss of mortar or spreading of the forms when concrete placement is resumed.

J. Set and maintain concrete forms so as to ensure that the completed work is within the tolerances specified herein.

K. Keep the deflection of wall or slab form sheathing or framing for beams within 1/270 of the span. Consider camber in designing the supports of beams and slabs.

L. Forms for outside surfaces shall be constructed with stiff wales at right angles to the stud, and all form ties shall extend through and be fastened to wales.

M. Chamfers: 3/4-inch at all exposed outside comers, including the top edges of all walls, machinery bases and curbs. Use mill run chamfer strips surfaced all sides. Provide rounded top edges of sidewalks, walkways and where directed.

N. Form ties:

1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally. After forms are removed, fill tie holes as follows:

   a. Remove form ties from surfaces.

   b. Roughen cone shaped tie holes by abrasive blasting before repair.

   c. Fill tie holes with dry-pack mortar as specified in Section 03 30 00.

2. Taper ties:

   a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:

      1) Clean and roughen tie holes.

      2) Drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.

      3) Locate steel rod in cylindrical recess during driving. At no time are plugs to be driven on flat area outside cylindrical recess.

   b. After installing plugs in tie holes, Dry-pack of taper tie holes:

1) Coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03 30 00.

a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.

b) Dry-pack the outside of the hole no earlier than 7 days after the inside of the hole has been dry-packed.

3.3 ALLOWABLE VARIATIONS FOR FORMED SURFACES

A. General: Set and maintain concrete forms to ensure that, after removal of the forms and prior to patching and finishing, no portion of the concrete work will exceed any of the tolerances. Measure variations in floor or roof levels before removal of supporting shoring. Accept responsibility for variations due to deflections resulting from concrete quality or curing other than that specified. The specified variation for one element of the structure will not be applicable when it will permit another element of the structure to exceed its allowable variation.

B. Tolerances: ACI 301 and the relevant subsections of ACI 117 and as noted below:

C. Variations in Size or Thickness:

1. Footings:

a. Length and width: ±1/2 inch

b. Reduction in thickness: 5%

2. Slabs and walls:

a. Thickness of 6 inches or less: 0 inch

b. Thickness of more than 6 inches: ±1/4 inch

3.4 REMOVAL OF FORMS

A. General: Remove without damage to the concrete and with complete safety of the structure. Ensure that the concrete has hardened sufficiently and the members have attained sufficient strength to safely support the imposed loads.

B. Forms for columns, walls, sides of beams and other parts not supporting the weight of the concrete may be removed only after the concrete has sufficient strength to resist damage from deflection, misalignment, cracking, spalling, and form removal operations, particularly when form ties will be bent by the removal operations, but not less than 3 days after concrete has been placed.

C. Falsework and forms supporting cast-in-place concrete beams, slabs, or other members subject to bending stresses shall not be removed or released less than 21

days after the concrete has been placed or until the concrete has reached the specified minimum compressive strength, whichever comes first.

D. Cold Weather: Engineer may increase the minimum form removal times if the temperature is 40°F or lower.

END OF SECTION

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SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Furnish and install reinforcement as shown on the drawings and as specified.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete

2. Section 05 05 19 – Anchor Systems

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 315 Details and Detailing of Concrete Reinforcement.

2. ACI 318 Building Code Requirements for Structural Concrete.

B. American Society for Testing and Materials (ASTM):

1. ASTM A615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

1.3 QUALITY ASSURANCE

A. Do not fabricate reinforcement until shop and placement drawings have been reviewed by Engineer. Contractor shall provide a concrete placing schedule to Engineer, before setting reinforcement, which clearly indicates the order of concrete placement for each structure.

B. Mill tests and tags:

1. Each bundle of steel shall be tagged by the mill with an identifying mill tag showing the name of the mill and the melt or heat number for the steel.

C. Test samples and approval:

1. Engineer may sample reinforcement at the source of supply or at point of distribution.

a. Two or more samples, each 24 inches long, may be taken at random from each size of bar in each melt or heat.

b. Contractor shall furnish test samples at no additional expense to the District.

2. Engineer will attach a tag to each bundle of steel that has been inspected, tested, and approved by the Engineer.

3. Certificates and tests will not be required if, in the opinion of the Engineer, the reinforcement is of such minor quantity that specified certificates and tests are impractical.

D. Replace all reinforcement with bends and kinks not shown on fabrication shop drawings. Remove from job site all such reinforcement and replace with new fabricated steel. Field bending of reinforcement at the work site is prohibited.

1.4 SUBMITTALS

A. Provide submittals per the contract documents.

B. Product Data:

1. Submit a certified copy of mill test of each heat, showing physical and chemical analysis to the Engineer at the time of sampling.

2. Submit a shipping invoice for each shipment showing the weight and heat number of each size of bar.

3. Bar supports and chairs.

4. Adhesive doweling system, if applicable, including evaluation reports by ICC Evaluations Services, Inc. see Section 05 05 19.

C. Shop Drawings:

1. Shop and placement drawings for all reinforced concrete structures to be reviewed by Engineer, including:

a. Reinforcement detailed in conformance with contract documents and with ACI 315;

b. All construction and expansion joints;

c. Assembly diagrams, including bar lap and splice locations and mechanical splice layout;

d. Accessories and inserts layout;

e. Bar supports including type, size, and spacing;

f. Marking for each reinforcement item.

2. Changes to Reinforcing Steel Contract Drawing Requirements:

a. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on Drawings for reinforcing steel.

b. Such changes will not be acceptable unless Engineer has accepted such changes in writing.

3. Review of shop drawings by Engineer will be limited to general compliance with Contract Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver reinforcement and accessories to work site with items of same size and shape fastened in bundles clearly marked with securely wired-on metal identification tags giving size and mark.

B. Store reinforcement and accessories off ground on platform or skid supports and protect with water resistant covers from snow, rain and ground splatter.

C. Protect reinforcement from rusting, deforming, bending, kinking and other damages.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing steel:

1. Provide newly rolled deformed billet-steel reinforcing bars conforming to ASTM A615, Grade 60.

2. Mill bend reinforcing bars cold to dimensions indicated and conforming to requirements of ACI 315.

B. Reinforcing Bar Supports:

1. Provide hot-dip galvanized steel with plastic tips at surfaces which will be exposed to view unless otherwise indicated on Drawings.

2. Use Stainless Steel when indicated on Drawings.

3. Use precast concrete block supports with embedded wire ties or dowels for placement on grade or on membranes. Cast the blocks with concrete equal in strength, cement type and aggregate to the parent concrete.

C. Tie Wire:

1. Provide 18 gauge or heavier, black annealed.

D. Adhesive for Dowels: Per contract documents.

PART 3 - EXECUTION

3.1 FABRICATION

A. After shop drawings are reviewed by Engineer, fabricate each unit of reinforcement to conform to the type, shape, and dimensions indicated on the fabrication shop drawings.

1. Bends shall be made using pin sizes as recommended by the American Concrete Institute.

2. Bars shall be bent cold unless preheating is approved in advance by the Engineer.

3. Bars reduced in section or having kinks or bends not shown on the contract drawings will not be accepted.

4. Detail and fabricate the reinforcing bars to provide minimum specified cover to outer edge of steel and other installed items as indicated on the drawings.

5. Provide splice development and embedment lengths as indicated on Drawings or specified herein to meet minimum ACI requirements.

6. Perform cutting and bending of reinforcing bars before shipment to the site. Bend bars cold and in a manner that will not injure the material.

7. Provide deformed reinforcing bar dowels at all construction joints, unless otherwise noted.

a. Provide same dowel size and spacing as the reinforcing to which they are spliced, unless otherwise noted.

B. Welding or mechanical connections as an aid to fabrication and/or installation will not be permitted except as specifically shown on the drawings, or as approved by the Engineer.

3.2 PREPARATION

A. Before placing in form, clean all reinforcement and accessories of mortar, oil, dirt, loose mill scale, loose or thick rust, and coatings of any character that would destroy or reduce the bond with the concrete.

B. Do not allow form coatings, release agents, bond breaker, or curing compound to contact reinforcement.

3.3 INSTALLATION

A. Place reinforcing bars to tolerances given in ACI 318 and as recommended by the CRSI "Practice for Placing Reinforcing Bars" except at specific locations where shown by the design drawings as requiring closer placing tolerances . Hold in position firmly and securely using tie wire with ends pointed away from forms.

B. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items, but not so as to impair design strengths of the member. If bars are moved more than two bar diameters, submit resulting arrangement of bars for review and acceptance by the Engineer. Place at least the required number of bars.

C. Set and tie all dowels before placing concrete. Setting dowels into wet concrete is prohibited.

D. Use chairs, bolsters and spacers to hold reinforcing bars in place, of sufficient strength to resist crushing under load in accordance with ACI 315. Metal chairs, ferrous clips, nails, etc. that extend to any surface of the concrete are not allowed. Stones, brick chips or wood block supports shall not to be used.

E. Use precast concrete bar support blocks for foundation mats, base slabs, footings, pile caps, grade beams, and slabs on grade.

F. Placing bars on layers of fresh concrete as the work progresses, and adjusting bars during the placement of concrete is prohibited.

G. Place bar laps in contact and tie securely, or space transversely apart to permit embedment of entire surface of each bar in concrete. Unless otherwise shown on the design drawings, laps shall be Class B splices per ACI 318.

H. Stagger lap splices in adjacent parallel bars whenever possible.

I. Tie a minimum of one-half, 50 percent, of all intersecting bars in foundation mats, base slabs, footings, pile caps, slabs on grade and elevated slabs.

J. Do not splice reinforcement steel in foundation mats, base slabs, beams, girders, slabs and walls at points of maximum stress unless otherwise indicated.

K. Provide continuous reinforcement through construction joints unless otherwise detailed or noted.

L. Do not use continuous reinforcement or other fixed metal items through expansion joints. Provide two-inch reinforcement clearance from each face of expansion joint.

M. Do not field bend bars, including bars partially embedded in concrete, unless otherwise indicated. Do not straighten or bend bars in manner injurious to steel or concrete.

N. Do not place bars that have kinks and bends other than shown on Engineer reviewed shop drawings. Remove all such damaged bars from job site and replace at no additional cost to the District.

O. Do not use heat to bend or straighten reinforcing steel.

P. Immediately paint all reinforcement which is to be exposed for more than 90 days with coat of neat cement grout to prevent rust formation.

Q. Where bars are to be lapped spliced at joints in concrete, ensure bars project from concrete first placed, minimum length equal to lap splice length indicated on Drawings.

R. Welded or mechanical connections (if required) shall be made at locations shown on the drawings or as approved by the Engineer.

1. Welded connections shall be per AWS D1.4, Latest Edition.

2. Mechanical connections shall develop 125% of reinforcing bar yield strength in either tension or compression.

3. Mechanical connections shall be per manufacturer's recommendations, conforming to the applicable code requirements.

3.4 FIELD QUALITY CONTROL

A. Inspect all reinforcement installation. Give Engineer 48 hours advance notice for inspection before concrete placement.

B. Special Inspections and Testing of Dowels: See Section 05 05 19 paragraph 3.3.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. All cast-in-place concrete required including structural, site work, and base pads for mechanical and electrical equipment.

2. Patching, grouting and curing of new concrete.

B. Related Sections:

1. Section 03 20 00 – Concrete Reinforcement

2. Section 05 05 19 – Anchor Systems

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. American Concrete Institute (ACI) standards including ACI 117, ACI 301, ACI 318-19 and ACI 350.

2. American Society for Testing and Materials (ASTM) publications for standard test methods including: C29, C31, C3, C39, C40, C42, C94, C114, C136, C143, C150, C171, C172, C231, C260, C289, C309, C330, C494, C618, C641, C979, C1077, D2419 and E154.

3. State of California Department of Transportation: Standard Specifications, latest edition (CSS)

B. Contractor Qualifications: minimum of 5 years of experience on similar wastewater facilities.

1. A foreman experienced in work being done shall be on the jobsite at all times.

C. Concrete Products and Materials Tests: Certified by independent commercial testing laboratory employed by the Contractor. Submit certification on cementitious products and aggregates performed within the past 12 months.

1. Batch plant shall be approved by the Engineer in advance of use for this work

D. Concrete Mix Designs: By independent commercial testing laboratory employed by the Contractor, and complying with ACI Chapters 19 and 26 and ASTM C1077.

The design submittal shall be signed by a California Registered Civil Engineer and approved by the Engineer.

E. Concrete Mix Test Results:

1. Submit result statistics of satisfactory mix designs from trial mix reports or, if available, from prior projects performed within past 5 years.

2. Allow adequate time for review and approval of submittals, and adjustments (if necessary) to comply with the Specifications, before placement of concrete.

F. Concrete Tests, as Placed:

1. The District will inspect and will perform strength tests on concrete cylinder samples in accordance with ASTM C 39.

2. Strength tests on core samples (if needed) will be performed in accordance with ASTM C 42.

3. Concrete Samples:

a. Casting of concrete cylinders and slump tests are to be performed by an independent special inspector hired by the contractor and witnessed by the District. The District will provide the molds for making concrete cylinders.

b. Contractor shall provide all equipment required to make the concrete samples, store them on site during initial cure, and deliver concrete cylinder samples to EBMUD Materials Testing Laboratory located at the address listed in Article 1.3. Contractor shall fill out Concrete Data Sheet at the time of pour and submit this form to the lab with the samples. Concrete Data Sheet will be provided by the Engineer.

c. Samples shall be made in accordance with ASTM C 31 and ASTM C 172. Provide site storage and initial cure, 24 hours minimum.

d. Unless specified elsewhere, a set of six standard 6-inch x 12-inch concrete cylinders shall be cast for each mix type placed, each day placed, or each 50 cubic yards placed or fraction thereof.

e. Label samples using a nomenclature provided by the Engineer.

f. Compressive strength: By EBMUD Materials Testing Laboratory in accordance with ASTM C39. (Typically two cylinders at age of 7 days, two at 28 days.)

4. Slump: By Contractor using slump cone in accordance with ASTM C143 and observed by the Engineer.

a. Test each sample used for strength tests, at beginning of each placement, as often as necessary to keep slump within specified range, and as requested by the Engineer.

b. Results outside the limits indicate possible cause for rejection of concrete. The Engineer shall be the sole judge.

5. Air content: Contractor shall test for percent of entrained air on concrete samples used for strength tests immediately after discharge from mixer per ASTM C231. Furnish calibrated equipment required to perform the test. See 2.5 C. for required air content.

G. Additional Core Samples and Tests:

1. If in the opinion of Engineer, results of tests on concrete cylinders indicate the possibility of substandard concrete in the structure, cored samples may be required to be taken from the concrete. The contractor shall provide all labor and equipment required to obtain the core samples.

a. The Contractor shall take 3 cores, in accordance with ASTM C42, from the area representing the cylinders in which the strength is in question and deliver them to EBMUD Materials Testing Laboratory for strength tests.

2. If, in the opinion of Engineer, the results of the core tests indicate that concrete has been placed does not meet this specification, remove and replace the defective concrete at no additional cost to District.

3. The Contractor may be reimbursed per Article 7 of the General Conditions for the coring cost if test results on the core samples indicate that the placed concrete meets the specification, and if it can be demonstrated that the original concrete cylinder samples were properly obtained.

H. READY-MIX CONCRETE

1. Supply concrete for the project using truck mixers and a ready-mix plant certified by the National Ready-Mix Concrete Association. Submit certification.

2. Alternatively, qualify the supplier according to ASTM C94 Sections 8 through 11, inclusive.

3. Verify that ready-mix batch plant delivery tickets contain all product information necessary for acceptance of the concrete delivered to site.

4. Verify that the mixing and trucking equipment have adequate capacity to deliver the concrete batches to site on time, thoroughly mixed and discharge without segregation.

1.3 SUBMITTALS

A. Provide submittals in accordance with the contract documents.

B. Product Data:

1. Concrete mix designs. See 1.2 D. and 2.5 A.

2. Portland Cement: Manufacturer's certificate of compliance with ASTM C 150 and standard physical and chemical analysis.

3. Pozzolan: Furnish with each shipment a certificate with test data showing compliance with ASTM C 618.

4. Aggregates: Furnish sieve analysis, physical properties and deleterious substance for both fine and coarse aggregates proposed for the work.

5. Coarse and fine aggregates: If requested, submit for the Engineer's approval, two weeks in advance of the concrete work, a representative sample of each size of fine and coarse aggregate to be used. Size of each sample shall be not less than 50 pounds.

6. Admixtures:

   a. Manufacturer's test data showing performance of product in concrete as to air content, water reduction, retardation, and effect on concrete strength at various ages, for concrete temperatures ranging 50 degrees F to 90 degrees F.

   b. If requested, submit 10-ounce sample of each product proposed for use in concrete mix.

7. Bonding Agents: Product information and the manufacturer's recommendations for the product application.

8. Water.

9. Ready-mix plant certification.

   a. Concrete Mix test results.

10. Curing materials and curing program.

C. Shop Drawings:

1. Construction and control joints layout.

2. Sequence of concrete pours.

D. Samples of materials required for testing under this section shall be submitted to the EBMUD Materials Testing Laboratory, 1100 21st Street, Oakland. A minimum of one day in advance, make an appointment for the sample delivery by calling the laboratory at (510) 287-1990 between 8:00 a.m. and 10:00 a.m.

1. Complete a submittal log for all Concrete Data.

E. Verification of Qualifications experience.

1.4 DELIVERY, STORAGE AND HANDLING

A. Cementitious Materials: If required at site, store immediately after delivery in a dry, weather tight, properly ventilated structure, with adequate provisions for prevention of moisture absorption and overheating of the cement.

B. Aggregates: If required at site, store in piles which afford good drainage and which are protected to prevent the inclusion of foreign material. Stockpile the various sizes or gradations of aggregates separately.

C. Lumber: Store all lumber, including plywood for forms, to prevent direct contact with the ground. Protect the stored lumber from the elements by a suitable covering, such as polyethylene film or waterproof building paper, suitably held in place.

PART 2 - PRODUCTS

2.1 GENERAL

A. Obtain materials from an established and experienced manufacturer or supplier. Provide new materials of first-class ingredients guaranteed to perform the service required.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:

1. Use only one brand of each cementitious material. The color shall not significantly alter the typical grey concrete color.

2. Portland Cement: ASTM C150, Type II, containing total alkali less than 0.6 percent.

3. Pozzolan: Fly Ash ASTM C618, Class F.

B. Aggregates:

1. General: ASTM C33

a. Provide free from organic materials, chlorides, waste products, clay balls, shale, and mica and thoroughly washed before use.

b. Provide aggregates that do not deleteriously react with the alkalis in the cement.

c. Grading: Submit results of sieve analysis.

d. Reactivity: ASTM C289. Submit graphical data showing compliance.

2. Coarse Aggregates:

a. Provide clean, hard, durable gravel, crushed gravel, crushed rock, or combinations.

b. Maximum size shall be 1-inch for all concrete on the project. For thin sections, such as slabs or walls 10 inches thick or less, or for sections that require special placement due to shape, form or congestion of reinforcing, provide ¾-inch maximum size.

c. Deleterious substances: Submit compliance with ASTM C33, Table 3 and as follows:

1) Cleanness: CALTRANS Test 227. For three tests, not less than 70, with an average greater than 75.

d. Do not use aggregate containing more than 10% of inferior materials, flat or elongated particles, cracked or laminated rock, or rock than can be readily broken after immersion in water for one hour.

e. When tested in accordance with ASTM C136, coarse aggregate shall conform to the following limits:

Sieve Size	Percentage Passing Primary Aggregate Nominal Sizes	
	1" x #4	3/4" x #4
1-1/2”	100	-
1”	88-100	100
3/4"	65-90	90-100
3/8”	15-35	15-40
No. 4	0-16	0-5

3. Fine Aggregate:

a. Provide natural sand or a combination of natural and manufactured sand, of siliceous, granite or igneous origin, hard and durable.

b. Deleterious substances: Submit compliance with ASTM C33 Table 1 and as follows:

1) Sand equivalent: ASTM D2419 or CALTRANS Test 217. For three tests not less than 70, with an average greater than 75.

c. When tested in accordance with ASTM C 136, fine aggregate shall conform to the following limits:

Sieve Number	Percentage Passing
4	95-100
8	65-95
16	45-85
30	25-55
50	10-35
100	2-12
200	0-8

d. Fineness modulus shall be not less than 2.50, nor more than 3.00.

e. Specific gravity S.S.D. shall not be less than 2.60.

4. Wetting of Aggregate:

a. Perform wetting of aggregate for cooling, or rewashing to provide clean aggregate, in advance of delivery into the batching plant bins. Material shall have uniform and stable moisture content as batched, and such that the variations in aggregate moisture will not cause variations in slump from batch to batch of more than 1/2 inch. Any added moisture shall be in accordance with the water cement ratio specified in the approved mix design.

C. Lightweight Aggregates:

1. General: ASTM C330

a. Provide free from organic materials, chlorides, waste products, clay balls, shale, and mica and thoroughly washed before use.

b. Maximum size shall be 1-inch for all lightweight concrete on the project. For thin sections, such as slabs or walls 10 inches thick or less, or for sections that require special placement due to shape, form or congestion of reinforcing, provide ¾-inch maximum size.

c. Provide aggregates that do not deleteriously react with the alkalis in the cement.

d. Organic Impurities: Tested in accordance with ASTM C40.

e. Staining: Tested in accordance with ASTM C641

f. Loss on Ignition: Tested in accordance with ASTM C114. Loss on Ignition shall not exceed 5%.

g. Clay Lumps and Friable Particles: Tested in accordance with ASTM C29. Test results shall not exceed 2% by dry mass.

h. Grading: Tested in accordance with ASTM C136. Test results shall conform to the requirements of ASTM C330, Table 1.

i. Bulk Density: Tested in accordance with ASTM C29. Test results shall conform to the requirements of ASTM C330, Table 2.

D. Water

1. Provide water for washing aggregates, for mixing concrete, for patching grout and for curing: Potable

2. Engineer may require tests of the water should there be a question of the quality. Costs of such tests would be borne by District.

E. Admixtures

1. Air Entraining: ASTM C260.

2. Water Reducing: ASTM C494, Type A or D.

3. No admixture containing any chloride ions is acceptable.

4. Pigments for integrally colored concrete: ASTM C979, for synthetic or natural oxides.

5. Provide permeability reducing admixture (PRA) for all concrete.

6. Acceptable manufacturers: Masterbuilders Masterlife 300 series, Xypex (hydrophilic crystalline admixture), Aquafin-IC Admix, Penetron Admix SB, or equal.

2.3 CONCRETE MIX DESIGN

A. General:

1. Employ an independent commercial testing laboratory per 1.2 D. and approved by the Engineer to design all concrete mixes and carry out all necessary testing that is not by the EBMUD Materials Testing Laboratory.

2. If the testing laboratory has satisfactory mix designs available from prior projects, submit test record statistics to demonstrate compliance with the requirements of this Section.

3. Take sole responsibility for selection of laboratory, submittal of materials to laboratories in time for all tests, and overall timing of all aspects of testing program, including submittals

4. If new mix designs are required, prepare a range of trial batches for each design and submit the mixes that demonstrate satisfactory test results.

5. Allow for the variability of concrete strength from test to test by increasing the required average compressive strength over the specified strength as specified in ACI 318-19, Chapter 5.

6. Design the mixes far enough ahead of concrete placement to allow completion of trial batch testing and submittal of the test results and mix design to the Engineer for review.

7. Mix designs shall account for concrete placement method by the batch process and/or by pumping, as required, and state the process on the design submittal.

8. Allow for the hot or cold weather and the time required to transport the concrete from the mixer to the site and to place within the forms. If accelerating or retarding admixtures will be required for only a proportion of the concrete placements, submit test results that include the full range of options.

9. Do not exceed the water-cementitious material ratios. Vary the water-reducing admixtures to accomplish an increase in slump or workability time.

10. Proportion cementations materials, aggregates, and water by weight.

11. Check periodically the weight of moisture contained within the stockpiled aggregates. Compensate for this water when proportioning the concrete mix and adjust when change occurs.

12. Do not use chlorides in any concrete mix.

B. Mixes:

1. Classes: Meeting requirements in Table A. All structural concrete shall be Class A unless otherwise noted.

TABLE A

Class	**Specified Compressive Strength fc' at 28 days, psi**	**Maximum Water Cement Ratio**	**Minimum Cementitious material per Cubic Yard of Concrete Pounds**
A	4,000	0.45	600

TABLE A			
Class	**Specified Compressive Strength fc' at 28 days, psi**	**Maximum Water Cement Ratio**	**Minimum Cementitious material per Cubic Yard of Concrete Pounds**
B	3,000	0.53	535
C	1,500	0.76	430

This table is based on 1" max aggregate size. For ¾" max size (or smaller) the cementitious material content will increase.

Fly Ash: 10% to 15 % of the weight of cementitious materials.

2. Consistency: Carefully mix concrete to produce homogeneous, fluid material capable of being worked into constricted areas of forms, corners and around embedded items, without segregation of free water bleeding. Provide slump ranges in Table B. Measure consistency by ASTM C143.

TABLE B		
Portion of Structure	**Slump, inches**	
	Maximum	**Minimum**
Walls 8-in. or more thick, footings and foundations mats	3	1
Walls less than 8-in. thick, slabs, beams, girders, columns, and fire-proofing around structural steel beams and columns	4	1
Provide additional slump if needed for pumped concrete to provide slump per Table B at discharge of pump line.		

C. Mix Test Requirements:

1. Compression: See 1.4 F.

2. Slump: ASTM C143. Slump range as shown in Table B.

3. Air Content: ASTM C231. 4 ± 1 1/2%.

4. After approval of the mix design, no variations of the constituents are permitted during the project without prior approval by Engineer.

D. Use Class A concrete for all concrete unless indicated otherwise. Use Class B concrete when indicated and when approved by the Engineer. Use Class C concrete whenever low-strength concrete is permitted by Engineer for concrete under foundations.

2.4 GROUT

A. Spreading over surfaces of construction joints:

1. One part of cement, two parts of sand (by weight), and only sufficient water to give required consistency for spreading.

2. Mix with no more water used than that allowed by water-cement ratio specified for concrete

3. Minimum compressive strength at 28 days shall be 4,000 psi.

B. Dry Pack:

1. One part of cement, two parts of sand (by weight), and only sufficient water so that resulting the grout will crumble to touch after being formed into ball by hand.

2.5 CONCRETE BONDING AGENT

A. Two-component liquid epoxy designed for bonding fresh concrete to existing concrete.

B. Approved products:

1. Concressive Liquid (LPL), manufactured by Master Builders and available from Muller Construction Supply, San Francisco, CA (415) 282-8001.

2. Sikadur 32, manufactured by Sika Corporation and available from D. M. Figley Co., Menlo Park, CA, (800) 292-9919.

3. Or equal.

2.6 FORMS – SEE SECTION 03 11 00

A. Form Coating Compounds

1. Do not stain or impart any material or residue to the concrete surface that will be detrimental or incompatible with any specified paint or coating system to be applied later.

2.7 CURING MATERIALS

A. Curing Compound: Consists of liquid which, when applied to fresh concrete by means of spray gun, will form impervious membrane over exposed surface of concrete with compound not preventing future bond of floor covering, and concrete floor treatment. Use Type I-D compound with red fugitive dye, Class B, in conformance with ASTM C309.

1. Manufacturers: One of the following or equal:

a. BASF Construction Chemicals, LLC, Shakopee, MN, Kure-N-Seal.

b. Euclid Chemical Company, Cleveland, Ohio, KUREZ DR.

B. Waterproof Curing Sheet: Waterproof paper or white opaque polyethylene film conforming to ASTM C171.

C. Cloth, Burlap, Jute or Kenaf: CCC-C-467C.

D. Vapor Barrier: Polyethylene sheet, 6 mils thick conforming to ASTM E154 or polyethylene-coated asphalt-saturated reinforced kraft paper.

PART 3 - EXECUTION

3.1 PROPORTIONING CONCRETE MATERIALS

A. Place no concrete prior to approval of submittals for reinforcing steel, materials specified in this Section and the mix proposed. Unfavorable results of actual pours may require a redesign of mixes.

B. Make no substitutions to the constituents tested in the design of concrete mixes without approval of the revised mix and the new test results.

3.2 BATCHING AND MIXING CONCRETE MATERIALS

A. Ready or Transit Mixed Concrete:

1. Deliver completely mixed to the project site.

2. Do not add mixing water during hauling. Add water after delivery only when agreed by the Engineer. Should water be added, revolve the mixing drum not less than 30 revolutions at mixing speed after adding and before commencing discharge.

3. Deliver each load at the job site accompanied by a ticket showing mix design number, volume of concrete, and the weight of cement in pounds and the total weight of each ingredient in pounds. Also show the time at which the materials were batched and the reading of the revolution counter at the time the truck mixer was charged.

4. The concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours or before the drum has completed 300 revolutions, whichever comes first, after introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates

5. Reduce batch sizes for ready-mixed concrete as necessary to avoid excessive mixing, loss of slump, and standby time.

6. No re-tempering of partially hardened material is permitted. Do not use partially hardened concrete in the work.

B. Batching in Adverse Weather:

1. Cold Weather: When the atmospheric temperature is below 40°F, or is likely to fall below 40°F during the 24-hour period after placing, heat the materials before mixing, so that the temperature of the mix when deposited shall be between 65° and 80°F. Do not heat the mixing water or the cement over 160°F. Remove lumps of frozen material and ice from the aggregates before they are placed in the mixer.

2. Hot Weather: When temperatures are above 90°F, reduce the temperature of the concrete mix by using iced mixing water, and protecting aggregates and cement from direct rays of the sun. Do not place concrete exceeding 80°F.

3. Should the provisions noted in 1. and 2. above not be possible or practicable, postpone the batching until favorable weather conditions prevail.

3.3 FORMS

A. General

1. If inadequate support is provided by the forms, remove all placed concrete and replace, as directed.

B. Formed Surfaces:

1. Ensure that the reinforcement has been approved before closing up the wall forms.

2. Provide exposed, unpainted concrete surfaces that are uniform in appearance and color. Apply non-staining mineral oil, form coating or form release compound before placing the forms. Remove any excess coating with cloths. Scrape and clean any reused forms before coating again.

3. Provide flush fitting caps over any unused form tie holes.

4. Do not use mineral oil on formed surfaces that are to be painted, coated, or bonded to other concrete.

C. Form Ties and Through-Bolts:

1. Provide sufficient number and strength to prevent spreading of forms while placing concrete.

2. Remove the removable portion immediately after stripping the forms. Avoid spalling the exposed concrete surfaces.

3. Locate tapered ties, if used, with the larger diameter on the water side of the form.

4. Provide a separate support system for the curtains of reinforcing, with a minimum 1-inch clearance between rebar and form ties or bolts.

D. Construction Joints:

1. Provide forms at ends of the first concrete pour. Ensure the end forms of walls are removable without releasing the side forms. Provide seals around reinforcement to prevent mortar leaks.

2. Overlap the hardened concrete of the first pour with forms for the second pour. Brace the ends of the forms against the hardened concrete to prevent joint offsets and mortar leakage. Align any exterior features required on the finished surface.

E. Removal of Forms

1. Re-shoring: Submit for approval, any requirement for accelerated partial stripping and re-shoring of forms that may be necessary to maintain the construction program.

F. Reuse of Forms

1. Between concrete placements, inspect all form surfaces and repair to uniform texture for all concrete surfaces to be exposed. Fill all unused holes, cracks and defects.

3.4 PLACING CONCRETE AND GROUT

A. Preliminary Work:

1. Remove hardened concrete and foreign materials from the inner surface of the mixing and conveying equipment. Remove all debris from the space to be occupied by the concrete.

2. Remove water from the space to be occupied by the concrete before concrete is deposited. Divert any flow of water into an excavation through proper site drainage to a sump, or by other methods. If required by the Engineer, grout up any water vent pipes and drains after the concrete has thoroughly hardened.

3. Provide satisfactory redundancy in the delivery system so that work can continue in the event of a breakdown.

4. Do not use aluminum materials in pumping lines, transfer hoppers or chutes longer than 12 feet. Provide conveyor belts instead of chutes when the distance is longer than 50 feet. Use a storage hopper at the start of the line.

5. For pumped concrete, provide a hose with an angle-change, to create a back- pressure at the outlet.

6. Provide illumination if necessary inside the forms, so that the placed concrete will be visible from the deck at top of formwork.

7. Provide thermometer for measuring concrete temperature when weather conditions are predicted to go beyond the range 50°F to 80°F.

B. Embedded Items:

1. Place all equipment, bolts, anchors, sleeves, inserts, structural steel members, angles and similar items that require embedment in the concrete.

2. All metal sleeves, inserts, anchors, and other embedded items shall be stainless steel unless shown otherwise. Set anchor bolts for equipment in templates, carefully plumbed and checked for location and elevation with an instrument, and held in position rigidly by double nuts to the template to prevent displacement while concrete is being poured.

3. Ensure that any aluminum items inserted in the concrete are isolated by a coating of coal-tar or equivalent.

4. Move reinforcement bars as necessary to avoid interference with other reinforcing steel, conduits, or embedded items, but not so as to impair design strengths of the member. If bars are moved more than two bar diameters, submit the resulting arrangement of bars for review.

5. Inspect the installation of all embedded items and reinforcing.

C. Placing:

1. Transfer the concrete to the place of final deposit as rapidly as practicable by methods that prevent the separation or loss of ingredients. Under no circumstances deposit partially hardened concrete in the work. Deposit concrete in the forms as nearly as practicable in its final position, to avoid re-handling. Maintain, until the completion of the pour, a plastic concrete surface, approximately horizontal.

2. Deposit concrete without segregation of the aggregate and without displacement of the reinforcement.

3. Maximum height of free fall for concrete during placement:

a. Concrete with maximum 4-inch slump: 4 feet

b. Concrete with high-range water reducing admixture and minimum 6-inch, maximum 9-inch slump: .....8 feet

4. Deposit concrete continuously or in layers 12 to 20 inches in depth so that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously as originally planned, locate construction joints during the placement.

5. Use every means to secure a dense, impervious, homogeneous concrete, free from voids or pockets. If honeycomb, air, or rock pockets occur, repair the structure to the complete satisfaction of the Engineer, and modify the placing method or mix design, to prevent recurrence of deficient concrete. Provide such repairs and modifications at no additional cost. Extensive honeycomb or pockets may be cause for rejection of the work.

D. Time Limit: Place all concrete in its final position in slab or forms within 1-1/2 hours of batching. Alternatively, as part of the mix design, provide admixtures that delay the initial set and state the proposed length of time in the submittal.

E. Temperature Limits:

1. Place all concrete in its final position in slab or forms at:

a. Less than 80°F, measured in the mix. See 3.2 B. 1.

b. More than 50°F, measured in the mix. See 3.2 B. 2.

2. Refer to the vibration, concrete joints and curing sections for other requirements.

F. Precast Items:

1. Items may be cast on or off the site.

2. Apply all applicable portions of Section 03 30 00, including materials, forms, placement, finish and curing.

3. Take particular care when handling and placing the precast items. Lift or move after a minimum of 90% of the specified compressive strength has been attained. Use the average compressive strength of two test cylinders.

3.5 VIBRATION

A. Compact the concrete with high frequency, internal mechanical vibrating equipment, and when required, supplement by hand spading and tamping. Consolidate slabs 6 inches or less in depth by hand tampers, spreading and settling with a heavy leveling straightedge.

B. Operate vibrators with vibratory element submerged in the concrete, with frequency between 8,000 and 12,000 impulses per minute when submerged.

C. Furnish sufficient vibrators to complete the compaction as specified without causing delay in the depositing of concrete. Provide at least one spare unit for each structure when concrete is being placed and at least one vibrator for each 25 cubic yards per hour of concrete placement.

D. Vibrate by direct action in the concrete for approximately 10 seconds at approximately 12-inch intervals, not against forms or reinforcements. Do not move concrete horizontally by vibration. Work the concrete around the reinforcement, and around embedded fixtures and into the corners of the forms. Penetrate 6 to 12 inches into previously poured layers as new layers are poured, provided the running vibrator penetrates by its own weight. To secure even and dense surfaces, free from aggregate pockets, honeycomb, or air pockets, supplement vibration when required by forking or spading by hand or hammering the forms lightly opposite the freshly deposited concrete. Re-vibrate the final layer. Stop vibrating when concrete is thoroughly compacted and has ceased to decrease in volume and give off air bubbles.

E. When placing concrete with 8-inch or more slump, reduce the time of vibration to 5 seconds and follow the admixture manufacturer's recommendations for technique.

3.6 CONCRETE JOINTS

A. Provide joints:

1. As shown on the Drawings.

2. As required for constructability.

3. After approval of layout, sequence and concrete placement program.

B. Provide minimum curing times before the second placement:

1. 2 days after the first concrete placement at the joint.

2. 10 days after each adjacent concrete placement, for infill pours for checkerboard placement pattern.

C. During placement of the new concrete, ensure there are no interruptions to the 14-day curing time and 14-day load restriction plan for the adjacent pours.

D. Control Joints:

1. Space typical slab joints not exceeding 10 feet, or as shown on the Drawings.

2. If cast-in with the concrete, positively locate the preformed joint filler and hold rigidly in place during concreting.

3. If saw-cut, use a wheeled power saw as soon as the concrete surface is firm enough. Use overtime as required if outside normal work hours. Notify District a minimum 3 days in advance if overtime may be needed.

4. Fill saw-cut grooves with sealant.

E. Construction Joints:

1. Produce quality concrete, with full continuity of reinforcing and water tightness across the joints unless otherwise detailed to control cracking.

2. Space typical slab joints not exceeding 20 feet in the direction of the transverse or secondary reinforcing, typically the smaller reinforcing nearer to the center of the slab thickness. Space typical vertical wall joints no more than 30 feet apart.

3. After the first concrete placement at the joint, do not walk on or disturb any reinforcing extending into the second placement area for at least 48 hours.

4. Before depositing new concrete on or against concrete that has hardened, clean and roughen the entire surface of the joint exposing clean coarse aggregate solidly embedded in mortar matrix. Provide typically 1/4-inch roughness or amplitude of the concrete surface measured from the top of the exposed aggregate to the bottom of pockets between stones.

5. Drench the prepared joint with clean water and remove prior to the concrete pour.

6. Cover horizontal wall and wall-to-slab joints with a minimum thickness of 1/2 inch and a maximum of 1 inch of grout immediately prior to placing new concrete.

F. Bonding to existing Concrete:

1. Mechanically roughen the old surface to 1/4-inch amplitude, as defined in construction joint paragraph above. Apply approved bonding agent, prior

to concreting, per the manufacturer's recommended installation procedures.

3.7 REPAIR OF DEFECTIVE CONCRETE

A. Inspect all concrete surfaces immediately after carefully removing forms. Defective work includes concrete out of line, level or plumb; cracks; poor joints; rock pockets; honeycomb; voids; spalls and exposed reinforcing. Patch all minor defects, including form tie holes, before the concrete is thoroughly dry. Do not interrupt the curing program. Ensure that repairs match the existing surface for color and texture.

B. Minor Defects:

1. Clean thoroughly, including removal of any curing compound. Cut out to solid concrete but to a depth of not less than 1 inch. Prepare the edges of the cut slightly more than perpendicular to the surface of the concrete, so as to form a key.

2. Repair with cement mortar. Use minimum water, consistent with the requirements of handling and placing. Thoroughly compact the material into place and screed off to leave the patch flush with the surrounding surface.

3. Keep the surface damp for at least 48 hours.

C. Major Defects:

1. Large areas involving voids or rock pockets extending through the section may be cause for rejection of the work.

2. If acceptable repairs can be made without adversely affecting the structural integrity of the work, cut out the section and either dry pack, or reform and re-pour to match the adjacent concrete. Do not cut out the reinforcing but cut keyways into the adjacent sound concrete to securely fasten the patch to the original work. Prepare edges of the damaged area with a minimum of a 1-inch cut perpendicular to the concrete surface.

3. Coat all surfaces with epoxy bonding agent immediately prior to patching. Place the concrete patch before the epoxy has set. Follow the epoxy bonding manufacturer's recommendations.

4. Provide a patch with strength and modulus of elasticity compatible with the parent concrete. Cure in accordance with the following article.

3.8 CURING CONCRETE

A. General:

1. Cure concrete by methods specified in this Section.

2. Cure concrete minimum of 7 days.

3. Water cure or plastic membrane cure concrete specified to be painted or to be sealed by concrete sealer.

4. Do not use curing compound on concrete surfaces upon which any material is to be bonded.

5. Curing compound may not be acceptable on surfaces exposed to sun and wind. See paragraph F.

6. Cure other concrete by water curing or sprayed curing membrane at Contractor's option.

B. Water Curing:

1. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days. Use sprinklers, fog spray, wet blankets or other approved method.

2. Each day forms remain in place may count as 1 day of water curing.

3. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.

4. Do not loosen form ties during period when concrete is being cured by leaving forms in place.

5. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.

C. Sprayed Membrane Curing:

1. Apply curing compound to concrete surface as soon as possible after finishing and within 1 hour after forms are removed.

2. If more than 1 hour elapses after removal of forms, do not use membrane curing compound, but apply water curing for full curing period.

3. If surface requires repairing or painting, water cure such concrete surfaces.

4. Curing Compound:

   a. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound. No hand pressurized tank sprayers will be allowed.

   b. Apply compound in at least 2 coats.

c. Apply each coat in direction 90 degrees to preceding coat.

d. Apply compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.

e. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.

f. Thickness and Coverage of Compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.

g. Contractor is cautioned that method of applying curing compound specified herein may require more compound than normally suggested by manufacturer of compound and also more than is customary in the trade.

h. Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.

i. Do not remove curing compound from concrete in less than 7 days.

j. Curing compound may be removed only upon written request by the Contractor and acceptance by the Engineer, stating what measures are to be performed to adequately cure structures.

k. Take care to apply curing compound in area of construction joints to see that curing compound is placed within construction joint silhouette.

l. Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete.

m. Contractor's Option: Instead of using curing compound for curing of construction joints such joints may be water cured.

n. If Contractor desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound and also similar adjacent area with specified compound in specified manner for comparison.

1) If proposed sample is not equal or better, in opinion of Engineer, in all features, proposed substitution will not be allowed.

o. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces

exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

D. Plastic Membrane Curing:

1. Polyethylene film may be used to cure slabs. Seal joints and edges with small sand berm.

2. Install plastic membrane as soon as concrete is finished and can be walked on without damage.

3. Keep concrete moist under plastic membrane.

E. Cold Weather Requirements: Provide adequate equipment for heating the placed concrete during freezing or near freezing weather:

1. Whenever the surrounding air temperature is below 40°F, or may fall below 40°F within the 24-hour period after pouring of concrete, maintain all freshly poured concrete at not less than 50°F for 5 days.

2. Keep the housing, covering, or other protection in place and intact at least 24 hours after the artificial heating is discontinued.

3. Do not use manure, salt, calcium chloride, or other chemicals on the concrete to prevent freezing.

F. Hot Weather Requirements: Provide additional cooling to concrete when temperatures rise above 90°F, or low humidity, wind and temperature combine to cause high surface evaporation, over 0.2 lb./sq. ft./hour:

1. Provide additional water if curing by fog spray or ponding or saturated blankets.

2. Provide shade to surfaces exposed to direct sunlight.

3. Apply an evaporation retarder during the finishing operation, following the manufacturer’s recommendation.

3.9 PACKING EQUIPMENT SUPPORT BASES

A. Dry pack under the equipment support bases using a mortar mixture consisting of one part cement to three parts of concrete sand.

B. Finish the resulting surface smooth at approximate one to one slope.

C. Cure in accordance with 3.8 above.

3.10 FIELD QUALITY CONTROL

A. Concrete Placement:

1. Verify that forms and reinforcement are accurately placed and secured in position. Confirm that both forms and reinforcement have been approved.

2. Verify that tie wire ends have been bent back away from the forms.

3. Verify that all sleeves, castings, pipes, conduits, bolts, anchors, and any other items required, are accurately and securely placed within or on the forms.

4. Verify adequate vibrators are available.

5. Verify construction joint faces have been prepared for the next concrete placement.

6. Check that the mix design is compatible with the method of placement of the concrete, by pump or by batch.

7. For wall placements, verify that the modified concrete mix required at construction joints is to be delivered.

8. Verify the concrete delivered to site is satisfactory, including checks on the batch tickets, quality assurance tests and direct observation of the batches.

B. Compressive Strength Tests:

1. See Article 1.2 F. Provide such facilities and equipment as are necessary to procure and handle representative samples of concrete, and to safeguard test cylinders stored at the site of the work.

C. Slump Tests:

1. See Articles 1.2 F and 2.3 B. Furnish all test equipment and perform tests observed by the Engineer.

2. Slump tolerance shall be plus or minus 1/2 inch.

D. Concrete Curing:

1. Verify procedures and equipment are available for controlling concrete temperature during hot and cold weather conditions.

2. Verify actual time of application of evaporation retardant, fog spray and curing materials for each placement.

3.11 CLEANUP

A. Upon completion of all work performed under this Section, remove from the site all excess materials, storage facilities and temporary facilities. Smooth and clean

of debris, all areas that were used or occupied during concrete construction operations and leave in clean condition.

END OF SECTION

SECTION 05 05 14

HOT-DIP GALVANIZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Hot-dip galvanize iron and steel items as shown on the drawings and as specified in this Section.

B. Related Sections:

1. Section 01 45 27 – Shop Inspections.

2. Section 05 50 00 – Metal Fabrications.

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A143 Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

3. A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. A384 Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

5. A385 Providing High-Quality Zinc Coatings (Hot-Dip)

6. A-780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Applicator: Regularly engaged in application of hot-dip galvanized coatings for at least two years immediately prior to this work. Provide samples of coating operation for approval.

2. Workers: Experienced and knowledgeable in preparation for and application of hot-dip galvanized coatings.

1.4 PRODUCT HANDLING, STORAGE AND DELIVERY

A. Handle all products to be galvanized in such a manner as to avoid any mechanical damage and to minimize distortion.

B. Load and store galvanized products to prevent formation of wet storage film.

1. Stack or bundle galvanized products to allow air between the galvanized surfaces.

2. Do not store galvanized products directly on the ground.

PART 2 - PRODUCTS

2.1 HOT DIP GALVANIZING REPAIR

A. Zinc based solder. All solders shall be lead free

1. Product

a. REGALV Galvanizing Repair Stick-Lead Free

b. Or Equal

B. Cold Galvanizing Sprays

1. Product

a. Rust-Oleum Cold Galvanizing

b. Or Equal

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Pre-clean steel work utilizing an alkaline cleaner, acid pickle, and flux. Alternatively, the steel shall be blast cleaned and fluxed.

3.2 APPLICATION OF COATING

A. Galvanize steel members, fabrications, and assemblies by the hot-dip process in accordance with ASTM A123.

B. Galvanize bolts, nuts, and washers, and iron and steel hardware components in accordance with ASTM A153.

C. Safeguard products against steel embrittlement in conformance with ASTM A143.

D. Clean damaged surfaces of galvanized metals and touch up with zinc-rich paint conforming to ASTM A780. Extent of repair area to be approved by the Engineer.

3.3 INSPECTION

A. All materials and workmanship shall be inspected to ensure that both fully meet these specifications. Any work found deficient shall be replaced and brought up to full compliance with these specifications.

B. Provide notification for Engineer prior to coating application. See Section 01 45 27 for inspection advance notification requirements and District travel expenses.

3.4 FIELD REPAIRS

A. The Engineer will determine whether items with defects or damage to coatings are to be returned to shop for recoating or whether touch-up in field is acceptable.

B. For indoor locations with low humidity: Field touch-up of defects or damage to coatings shall be with a minimum of two coats of a compatible cold galvanizing product, as approved by the Engineer.

C. For all outdoor locations or indoor locations with high humidity: Field touch-up of defects or damage to coatings shall be with zinc based soldering rods per ASTM A780. Repair shall be followed by one coat of compatible cold galvanizing product as approved by the Engineer.

D. Defect areas shall be slightly hand roughed up (not significantly removing galvanized coating) using 100 grit aluminum oxide sand paper including surrounding area within one inch of defect. Entire sanded area including defect shall be coated.

END OF SECTION

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SECTION 05 05 19

ANCHOR SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Includes: Complete anchoring systems in concrete including, but not limited to, equipment anchors and reinforcement dowels.

1. Anchor Bolts.
2. Adhesive Anchor Systems.
3. Expansion Anchors.

B. Related Sections:

1. Section 03 20 00 - Concrete Reinforcing.
2. Section 03 30 00 - Cast-In-Place Concrete.
3. Section 05 50 00 - Metal Fabrications.

1.2 REFERENCES

A. American Concrete Institute:

1. 355.2-19 Qualification of Post-Installed Mechanical Anchors in Concrete.
2. 355.4-19 (Reapproved 2021) Qualification of Post-Installed Adhesive Anchors in Concrete.

B. American Institute of Steel Construction (AISC):

1. 360-16 Specification for Structural Steel Buildings.

C. American Society for Testing and Materials (ASTM):

1. A 36-14 - Specification for Structural Steel.
2.
3. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

D. International Code Council (ICO):

1. 2021 International Building Code (IBC).

E. California Building Standards Commission

1. 2022 California Building Code (CBC).

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 Submittal Procedures.

B. Product Data: Fully describe every product proposed for use and manufacturer's installation instructions.

C. Calculations and reference drawings for the anchorage of equipment, or any other items, that Contractor is responsible for the design of. See also Section 01 33 12 Seismic Design Criteria.

D. Qualifications of Installers and Testing Laboratory

1. Submit each Installer's qualifications and training date per Paragraph 1.4 A. 1.

2. Submit Testing Laboratory's qualifications for proof load testing.

E. Test Reports:

1. International Code Council Evaluation Service, Inc. (ICC-ES), Evaluation Service Reports based on the following acceptance criteria:

a. AC308 – Adhesive Anchors and Dowels.

b. AC193 – Expansion Anchors and Undercut Anchors.

2. Field tension proof load test reports per Paragraph 3.3 C. Include type, manufacturer, model and size of anchors or dowels tested.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Adhesive, expansion and undercut anchors shall be installed by installers who have:

1. A minimum of one year (1) of experience performing similar installations;

2. A thorough training with manufacturer or manufacturer's representative on the project. Training shall consist of a review of complete anchor installation including but not limited to:

a. Hole drilling procedure.

b. Hole preparation and cleaning technique.

c. Adhesive injection technique and dispenser training.

d. Rebar dowel preparation and installation.

e. Proof loading and torque tightening.

B. Any epoxy rebar dowels or all-thread installation shall be witnessed by a special inspector hired by the contractor.

C. Special Inspections and Testing:

1. Comply with 2022 CBC Chapter 17 and Article 3.3 of this Section. Provide adequate notice of all anchor installations to allow District Inspector to perform either periodic or continuous inspection at District's discretion.

2. Independent laboratory testing of anchor systems shall be paid by the Contractor.

3. Any pull testing of rebar dowels or all-thread shall be performed by a special inspector hired by the Contractor. Reports shall be submitted to the Contractor and uploaded to the CMIS. This activity shall be witnessed by the District Inspector.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver bolts free from mill scale, rust, and pitting.

B. Storage and Protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast-In-Place Anchor Bolts:

1. Bolts and nuts: Type 316 stainless steel conforming to ASTM F593, unless otherwise indicated on Drawings.

a. Mechanical Properties:

1) fy = 45 ksi, min.

2) fu = 85 ksi, min.

2. Washers: Type 316 stainless steel conforming to ASTM A240, unless otherwise indicated on Drawings.

3. All anchor bolts shall have a standard hex bolt head, unless otherwise indicated on Drawings.

B. Adhesive Anchor System:

1. Adhesive (not within tanks or channels):

a. Seismic qualified for 2021 IBC and tested per ICC-ES AC308.

b. Used with all-threaded rods, internally-threaded inserts, or deformed reinforcing bars in cracked and un-cracked concrete per Evaluation Service Report (ESR).

c. Meet requirements of AASHTO specification M235, Type IV, Grade 3, Class A, B, or C except gel times.

d. Injectable two-component epoxy adhesive furnished in containers which keep component A and component B separate. Containers shall be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Use injection tool and static mixing nozzles recommended by manufacturer.

e. Properties:

1)	Bond Strength (ASTM C882):	1,690 psi, Min.
2)	Compressive Strength (ASTM D695):	12,000 psi, Min.
3)	Compressive Modulus (ASTM D695):	0.22 x 10^6 Min.
4)	Tensile Strength 7 days (ASTM D638):	6,310 psi, Min.
5)	Elongation at Break (ASTM D638):	1.1%
6)	Heat Deflection Temperature (ASTM D648):	122ºF
7)	Absorption (ASTM D570)	0.06%
8)	Linear Coefficient of Shrinkage on Cure (ASTM D2566)	0.004

f. Do not use adhesive with all-threaded rods, internally-threaded inserts, or deformed reinforcing bars to resist tension in overhead position unless otherwise indicated on drawings or specified.

g. Manufacturers: one of the following or equal:

1) Hilti HIT-RE 500 V3 ESR-3814;

2) Simpson Strong-Tie SET-3G Epoxy Adhesive, ESR-5334

2. Anchors:

a. Anchors shall be all-thread rods and shall be Type 316 stainless steel conforming to ASTM F593 (AISI 304/316 SS) condition CW unless otherwise indicated on Drawings.

1) Mechanical Properties:

a) fy = 45 ksi, min.

b) fu = 85 ksi, min.

b. All-thread rods shall be furnished with chamfered ends so that either end will accept a nut and washer. If recommended by the manufacturer, one end shall have a 45-degree chisel point that will be inserted into adhesive-filled hole.

c. All-thread rods shall be free of oil or coatings that may reduce bond.

d. Manufacturers:

1) Hilti, HIT-HAS, 316SS, for all-threaded rods.

2) Or equal.

3. Dowels:

a. Newly rolled deformed billet-steel reinforcing bars conforming to ASTM A615, Grade 60.

b. Embedment, splice and development lengths as specified and indicated on Drawings.

c. Dowels shall be free of oil, grease, paint, dirt, mill scale, dust, or other coatings that will reduce bond.

d. Provide same dowel size and spacing as the reinforcing to which they are spliced.

e. Detail and fabricate reinforcing bars to provide specified cover to outer edge of steel and other installed items as indicated on Drawings.

f. If recommended by the adhesive manufacturer, one end shall have a 45-degree chisel point that will be inserted into adhesive-filled hole.

C. Expansion Anchor System:

1. Seismic qualified for 2021 IBC and tested per ICC-ES AC193.

2. Expansion anchor shall be suited to seismic and cracked concrete application.

3. Anchor shall be torque-controlled. wedge-type, with a single piece three-section wedge and fully treaded stud, completed with required nuts and washers. Anchor shall meet description of Federal Specification A-A 1923A, Type 4.

4. Anchor bodies, wedges, nuts and washers shall be Stainless Steel, Type 316. Studs and wedges shall conform to ASTM A276 or ASTM F593. Nuts shall conform to ASTM F594, and washers ASTM A240.

   a. Mechanical Properties:

      1) fy = 76 ksi, min.

      2) fu = 100 ksi, min.

5. Do not use expansion anchors to resist tension in overhead position unless otherwise indicated on Drawings.

6. Manufacturers: One of the following or equal:

   a. Hilti, Kwik Bolt TZ2 Expansion Anchor;

   b. Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.2 ERECTION

A. General:

1. Verify length of bolt or dowel projection from concrete. Obtain bolt and fabricate dowel with length providing minimum embedment as required.

2. Verify location of anchors in existing concrete shall miss existing embedded items including reinforcing bars and electrical conduits.

   a. Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device. If an Independent Testing Agency is required to perform nondestructive survey they shall be directed and paid by the Contractor.

B. Anchor Bolts:

1. Use templates to locate bolts accurately and securely in formwork.

2. Accurately locate anchor bolts embedded in concrete with bolts perpendicular to surface from which they project.

3. Do not allow anchor bolts to touch reinforcing steel.

4. Where anchor bolts are within ¼ inch of reinforcing steel, isolate with a minimum of 4 wraps of 10 mil polyvinyl chloride tape in area adjacent to reinforcing steel.

5. In anchoring machinery bases subject to heavy vibration, use 2 nuts, with 1 serving as a locknut.

6. Where bolts are indicated on the Drawings for future use, first coat thoroughly with non-oxidizing wax, then turn nuts down full depth of thread and neatly wrap exposed thread with waterproof polyvinyl tape.

7. Furnish anchor bolts with standard hex bolt head unless otherwise indicated on the Drawings. Where anchor bolts with 90 degree hooks are indicated on the Drawings, provide anchors with minimum 4 diameter hook length.

8. Embed anchor bolts 10 diameters minimum unless otherwise indicated.

9. Where indicated on Drawings, set anchor bolts in metal sleeves having inside diameter approximately 2 inches greater than bolt diameter and minimum 10 bolt diameters long. Fill sleeves with grout when a machine or other equipment is grouted in place.

C. Adhesive Anchor System

1. Accurately locate rods, inserts or dowels, and set perpendicular to surfaces from which they project.

2. Do not use adhesive anchor to substitute for anchor bolt unless approved by District.

3. Do not install rods, inserts or dowels until the concrete has reached the specified 28-day compressive strength.

4. Do not fabricate or purchase rod, inserts or dowels until drill-ability of holes and accessibility for installation has been verified. Relocate, reshape or add rods, inserts or dowels as required to miss embedded items with minimum clearance and as approved by District.

5. Installation shall be in accordance with the latest ICC Evaluation Service Report and the anchor manufacturer’s instructions.

6. Drilling Holes:

a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by the District.

b. Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device prior to: final fabrication of anchor holes in hardware to be anchored; and final resolution of hole location with approval by District.

7. Hole Drilling Equipment:

a. Electric or pneumatic rotary type with medium or light impact.

b. Drill Bits: Carbide-tipped in accordance with ANSI B212-15.

c. Hollow drills with flushing air systems are preferred. Air shall be free of oil, water, or other contaminants which will reduce bond.

d. Where edge distance is less than 4 inches, use lighter impact equipment to prevent cracking and spalling of the concrete during the drilling process.

8. Hole Diameter:

a. As recommended by adhesive anchor system manufacturer.

9. Install rods, inserts and dowels at locations as indicated on the Drawings and with the required depth and spacing.

10. Cleaning Holes:

a. Insert long air nozzle into hole and blow out loose dust. Use air which is free of oil, water, or other contaminants which will reduce bond.

b. Use a stiff bristle brush to vigorously brush hole to dislodge compacted drilling dust.

c. Repeat steps a. and b. as required to remove all drilling dust or other materials and leave holes clean and dry for rods, inserts and dowels.

11. Cleaning rods, inserts and dowels:

a. Degrease over embedment length. Rods, inserts and dowels shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.

12. Minimum Embedment Depths (unless greater depth is noted on drawings or lesser depth is submitted for approval with supporting calculations):

a. All-threaded Rods:

Anchor Diameter (inch)	Min. Embedment (inches)
1/2	4
5/8	5
3/4	6
7/8	7 1/2
1	9

b. Inserts: Per manufacturer.

c. Dowels:

Bar size	Min. Embedment (inches)
#4	6
#5	7
#6	8
#7	9

D. Expansion Anchors:

1. Do not use expansion anchor to substitute for anchor bolt unless approved by District.

2. Accurately locate anchors and set perpendicular to surfaces from which they project.

3. Installation shall be in accordance with the latest ICC Evaluation Service Report and the anchor manufacturer's instructions.

4. Drilling Holes:

   a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without approval by the Engineer.

   b. Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device prior to: final fabrication of anchor holes in hardware to be anchored; and final resolution of hole location with approval by District.

5. Hole Drilling Equipment: Use the following unless otherwise specified in the latest ICC Evaluation Service Report for the anchor and the manufacturer's instructions.

   a. Drill: Electric or pneumatic rotary type with medium or light impact.

b. Drill Bits: Carbide-tipped in accordance with ANSI B212-15.

c. Hollow drills with flushing air systems are preferred. Air shall be free of oil, water, or other contaminants that will reduce bond.

d. Where edge distance is less than 4 inches, use lighter impact equipment to prevent micro-cracking and concrete spalls during drilling process.

6. Minimum embedment depths (unless greater depth is recommended by manufacturer or noted on drawings, or lesser depth is submitted for approval with supporting calculations):

a. Expansion Anchors:

Anchor Diameter (inch)	Embedment Depth (inches)
3/8	2-1/2
1/2	3-7/8
5/8	5-1/8
3/4	5-3/4
1	9-3/4

3.3 FIELD QUALITY CONTROL

A. Inspections of anchors in concrete shall be done by the District's Inspector in accordance with Section 1705 of the 2019 CBC and Article 17.8 of ACI 318-14 including the following for post-installed (adhesive, and expansion) anchors:

1. Product description including product name, expiration date, nominal size and grade of anchors and dowels, and embedment depth;

2. Hole description including verification of drill bit diameter per Manufacturer's instructions and in compliance ANSI B212.15-1994, hole depth, and cleanliness;

3. Installation description, including verification of concrete type and compressive strength, and verification of anchor installation and location (spacing and edge distance) in accordance with Manufacturer's published installation instructions and ICC-ES Report.

4. Verification of installer qualifications.

B. Contractor shall employ an independent Testing Laboratory to perform proof load testing of adhesive anchors.

C. Field Tension Tests (proof loads) for adhesive system anchors and dowels by an independent Testing Laboratory.

1. Test after adhesive has cured. Proof loads depend on the characteristics of each anchor type including embedment, edge distance and concrete strength. In general the proof load shall be 1.1 times the design required tension strength ($øN_n$) per ACI 318-14 Chapter 17 and the current ICC-ES Report for the anchor system used; however it shall not exceed 80% of the steel yield strength nor 2/3 of the nominal concrete breakout strength. The test loads shall be determined by the anchorage designer and verified by the Engineer after the anchors have been installed.

2. Test at least 5% of each type and size of anchors and dowels, but no less than one (1) test of each anchor and dowel in each distinct area of work.

3. Loads shall be applied with a calibrated hydraulic ram for a minimum of 10 minutes.

4. Displacement of adhesive anchors and dowels shall not exceed D/10, where D is nominal anchor or dowel diameter.

5. If any anchor or dowel fails to hold the test load or meet the above criteria, test additional 10% of each type and size of anchor or dowel that failed. If any additional failures occur, test all anchors of the type and size that failed.

6. Reinstall all failed anchors and dowels, and test them as directed by District.

D. Access for Testing and Sample Dowels:

1. Examine concrete surfaces where dowels must be tension tested. When existing reinforcement is present, verify accessibility for tension test. Tension test dowels prior to placing surrounding new reinforcement.

2. Where dowels are inaccessible for tension test, install sample dowels for testing at alternative similar locations as directed by District.

E. Cost of special inspections, testing, sample dowels and reinstalled anchors and dowels, due to failure, shall be borne by Contractor.

3.4 REPAIR OF DEFECTIVE WORK

A. Anchors and dowels that fail to meet installation toque requirements or proof load test shall be regarded as malfunctioning. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with non-shrink epoxy grout.

END OF SECTION

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SECTION 05 05 24

SHOP AND FIELD WELDING

PART 1 - GENERAL

1.1 SUMMARY

A. Use this section for welding requirements of the related sections as described in 1.1.B and as listed in 1.1.C.

B. Section includes:

1. Shop and field welding of structural steel and other metals

2. Third-party independent inspection and examination of welds

C. Related Sections:

1. Section 05 50 00 – Metal Fabrications

1.2 APPLICABLE CODES AND STANDARDS

A. AWS D1.1 – Structural Welding Code – Steel, 2020 edition

B. AWS D1.6 – Structural Welding Code – Stainless Steel, latest edition

C. AWS 3.0 – Standard Welding Terms and Definitions, latest edition

D. AWS A2.4 – Standard Symbols for Welding, Brazing and Nondestructive Examination, latest edition.

1.3 TERMS AND DEFINITIONS

A. Certified Welding Inspector (CWI) – A person certified as a welding inspector as given in AWS QC1- Latest Edition, Standard for AWS Certification of Welding Inspectors.

B. Nondestructive Examination (NDE) – The act of determining the suitability of some material or component for its intended purpose using techniques that do not affect its serviceability.

C. NDE Level II Technician/Operator (NDE Level II): An individual certified at Level II as defined in American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-1A specific to the NDE method used.

D. Procedure Qualification Record (PQR) – A record of welding variables used to produce an acceptable test weldment and the results of tests conducted on the weldment to qualify a welding procedure specification.

E. Welding Procedure Specification (WPS) – A document providing the required welding variables for a specific application to assure repeatability by qualified welders and welding operators. WPSs that are not prequalified by Code shall be supported with a PQR.

F. Standard Welding Terms and Definitions: See AWS 3.0, Standard Welding Terms and Definitions.

1.4 SUBMITTALS

A. Contractor's Field Welding Plan:

1. Submit a Field Welding Plan listing each WPS to be used on the project and indexing that WPS to the drawing and weld. All joints requiring radiographic testing per this section shall be clearly identified in the Field Welding Plan, and radiographic testing activities shall be shown on the Contractor's three week look ahead schedule as required in Project Meetings.

2. Following the scheduling of radiographic testing by the Contractor, a pre-testing meeting shall be scheduled by the Contractor. Attendees shall at a minimum include the third-party CWI, representatives from the company performing the radiographic testing including the actual technicians that will perform the testing, the Contractor's representative, and representatives from the District including the Plant Inspection Section. The meeting shall be scheduled via a Plant Inspection Request.

B. Qualification of Welders and Welding Procedures:

1. For field welding for Section 05 50 00 – Metal Fabrications, submit records consistent with Paragraph 1.6, shop and field welding requirements.

2. For pipe welding submit records consistent with: Paragraph 1.5.A for procedure qualifications; Paragraph 1.5.B for shop welder qualifications; and, Paragraph 1.5.C for field welder qualifications.

C. Qualification of Inspectors and NDE Examiners:

1. Submit verifiable evidence of the current CWI certification of all third party CWIs.

2. Submit verifiable evidence of the certification of all personnel performing NDE or interpreting the test results to ASNT-TC-1A Level II as a minimum.

D. Submit complete fabrication and erection drawings for the Engineer's approval prior to cutting or fabrication. Shop drawings shall show the details of fabrication with weld symbols in accordance with AWS A2.4 for all joints to be welded.

E. Provide all submittals to the Engineer with sufficient review time for approval prior to start of welding. Welding shall not proceed until the related submittals are approved by the Engineer.

1.5 QUALIFICATIONS AND INSPECTIONS

A. Pipe-Welding Procedure Specifications:

1. All welds shall be completed in accordance with a qualified WPS.

a. The Contractor may use a prequalified WPS conforming to the provisions of AWS D1.6 – Clause 5, Prequalification of WPSs.

2. All WPSs that are not prequalified as given above shall be qualified in accordance with one of the following:

a. AWS D1.6 – Clause 6

3. A CWI shall review and stamp all WPSs and PQRs.

B. Pipe Welding, Shop:

1. Welders shall be qualified under AWS D1.6 – Clause 6, for the welding processes, positions, and procedures to be used for this project.

2. Welders shall have verifiable evidence they have maintained their qualifications in accordance with AWS D1.6 – Clause 6

3. Welder Qualification(s) shall be witnessed and stamped indicating acceptance by a CWI.

C. Pipe Welding, Field:

1. Prior to the start of welding on this project, each welder shall perform welder qualification testing specific to the welding on this project. Only welders that pass welder qualification testing for this project will be allowed to weld on this project. Prior welder qualification records will not be accepted. All welder qualification tests will be at the expense of the Contractor. Qualifications shall be in accordance with AWS D1.6-Clause 6 for each process, position and procedure to be used on the project.

2. Welder qualification testing shall be witnessed by a third party AWS CWI provided by and at the Contractor's expense. Upon successful completion of testing, the AWS CWI shall stamp, sign and date the welder qualification form.

3. The Engineer reserves the right to witness all welder qualification tests and be present for all weld coupon testing.

D. Metal Fabrication Welding as specified in Section 05 50 00 – Metal Fabrications

1. Stainless Steel welding shall conform to ANSI/AWS D1.6 latest edition – Structural Welding Code – Stainless Steel.

2. Certification of Welders:

a. Submit verifiable evidence of initial qualification for each welder.

b. Submit verifiable evidence each welder has maintained current qualification(s).

3. Submit WPSs with supporting PQRs for approval per **Error! Reference source not found.** above.

E. Testing and Inspection:

1. The Contractor shall provide independent inspection of all structural steel framing welds and nondestructive examination (NDE) as indicated on applicable Contract Drawings. The District will perform direct visual verification of these inspections and tests. Notify the District's Plant Inspection Section at (510) 287-1132 for all field testing and shop inspections and tests.

2. Welding inspection personnel shall be certified in accordance with AWS QC1 at the level of Certified Welding Inspector.

3. NDE personnel shall be certified in accordance with ASNT-TC-1A Level II as a minimum.

4. Inspections and test results shall comply with AWS D1.6 Clause 8 for the related inspection and test method.

5. The costs of all inspections and tests, including retests after repair, shall be borne by the Contractor.

F. Tolerances:

1. Dimensional tolerances and allowances for fit shall be in accordance with applicable AWS Standards unless shown otherwise. Tolerances and allowances shall be shown on the Contractor's erection or working drawings.

1.6 RETESTING OF WELDERS BASED ON QUALITY OF WORK:

A. When the quality of a welder's work appears to be below the requirements of this specification or referenced Codes, the Engineer may require that the welder demonstrate an ability to produce sound welds by requiring complete

requalification in accordance with the latest edition of AWS D1.6, Clause 6. All re-qualifications will be at the Contractor's expense.

1.7 NONDESTRUCTIVE EXAMINATION-GENERAL

A. Types of NDE and Acceptance Criteria:

1. Radiographic Examination (RT) per Paragraph UW-51, Section VIII, ASME Boiler & Pressure Vessel Code

2. NOT USED.

3. Magnetic Particle (MT) per Section V, ASME Boiler & Pressure Vessel Code. Acceptance criteria shall be as given by AWS D1.1 – Clause 8, Part C

B. Nondestructive Examination of Production Welds:

1. In addition to any NDE required by the Contract Documents, the Engineer may elect to perform additional NDE of in-process or completed shop or field welds to verify weld quality. Any additional NDE may be performed by District personnel or the Engineer may request the Contractor perform or subcontract these examinations.

2. Cost of Examinations:

a. The cost of NDE identified in the Contract Documents for specific welded connections shall be borne by the Contractor.

b. The cost of additional NDE requested by the District will be borne by the District in the event that all examined welds are found to be acceptable. In the event of a rejected weld, the Contractor shall bear the costs of all NDE, including NDE of weld seams found to be acceptable, as well as the costs of repairs, re-inspection and re-examination of the rejected weld.

c. The cost of NDE performed by District personnel will be borne by the District. The costs of repairs, re-inspection and re-examination resulting from a rejected weld shall be borne by the Contractor.

1.8 CLEANING AND PASSIVATING OF STAINLESS STEEL WELDMENTS

a. Larger than 2-inch pipe joints and structural steel, including the entire heat-affected zone (HAZ), shall be:

1) Cleaned in accordance with ASTM A380. The joints shall be visually inspected to be free of paint, oil, grease, welding flux, slag, heat-treating and hot-forming scale, dirt, trash, metal and abrasive particles and chips, and other gross contamination. Dust may be present on the exterior surfaces, but should not be on the interior surfaces.

2) De-scaled (pickled) with citric acid per in accordance with ASTM A380 Table 2.1, Part III. Perform intermittent scrubbing as required to assure a completely cleaned surface. Do not use a steel wire brush.

3) Passivated per ASTM A380 with final cleaning per ASTM A380 Table 2.1, Part II, and in accordance with ASTM A967. The finish shall be inspected to be free of contaminating iron particles, heat-tint oxides per AWWA C220, weld scale, and other impurities.

4) Follow immediately with a thorough rinse and water-jet spray to remove excess acid to prevent attack of the base metal.

5) Both the exterior and interior of the joint and HAZ shall be treated. Inaccessible interior joints, as approved by the Engineer, shall be omitted from this process.

b. The weld and HAZ shall be tested per ASTM A967 to be free of contaminating iron particles and other impurities. The ASTM A967 test method used shall be approved by the Engineer.

c. 2-inch and smaller pipe joints: Shop welded stainless steel pipe joints shall be treated as described above when called out on the drawings.

d. At branch locations, if any of the joined pipes are larger than 2-inches, joints shall be treated as described above.

1.9 VERIFICATION

A. General Requirements:

1. All welds shall be visually inspected and accepted by the Contractor's Third-Party CWI and the Engineer prior to performance of all NDE, including hydrostatic and air tests. Final visual inspection shall be performed after the weld has cooled to ambient temperature.

2. In-process and final inspections shall be documented on the attached "Field Welding Inspection Form" by the Contractor's Third-Party CWI, and available for review by the Engineer. At a minimum, all applicable elements listed on the form are required.

3. All visual inspections and nondestructive examinations shall be completed and confirmed as acceptable by the Engineer prior to further processing that could

B. Radiograph Records:

1. All radiographs, including information only examinations, will become the property of the District.

a. The Fabricator shall provide to the District all hardware and software necessary to review the radiographs. The Fabricator shall provide one set of hardware and software to the District prior to the start of radiography for retention by the District.

b. The Contractor shall provide the District with one new film viewer as follows: LC NDT FV-2010-T-PLUS High Intensity Portable LCD Film Viewer with Built-in Densitometer and Electronic Masking, or equal as approved by the Engineer.

C. Field Inspection:

1. Responsibilities

a. The Contractor shall provide third party CWIs and NDE Examiners. Third party inspectors and examiners shall be independent from work production and schedule responsibilities. Third party CWIs and NDE Examiners shall provide daily reports, documented on the attached "Field Welding Inspection Form" to the Engineer for all work performed. The reports shall be signed and stamped and provide a clear summary of the inspection or NDE activities performed, direct traceability to the work, and a determination of acceptability.

b. The District will verify that the third party independent inspections and NDE comply with these requirements, including referenced Codes and Standards, and will review and accept (or reject) the reports of the CWIs and Examiners. The Engineer may at any time verify by direct inspection or surveillance the acceptability of all phases of welding and third party independent inspection and NDE activities.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES

A. Use Shielded Metal Arc Welding (SMAW), Flux Cored Arc Welding (FCAW), Gas Tungsten Arc Welding (GTAW), or Gas Metal Arc Welding (GMAW-Spray or Globular modes only), unless the Engineer approves another process prior to use.

1. Gas Metal Arc Welding (Short-Circuit) is not allowed.

B. All welds shall be made according to an approved WPS.

C. Each step of the welding process will be inspected and approved before proceeding to the next step.

D. Welding shall be performed in at least two layers. Passes shall not exceed 1/4 inch in throat dimension.

E. Welds shall be thoroughly cleaned after each pass.

F. Welds shall be fully fused with base metal, uniform in appearance, free from cracks and reasonably free from irregularities. Weld shall blend smoothly and gradually into the base material

G. Restart in weld zone on clean and sound metal.

H. Remove defective welds by chipping, grinding, flame gouging, or air-arc gouging and repair by re-welding.

I. No undercut is allowed.

J. Use procedures or welding sequences that will minimize eccentric stresses, shear or distortion in the weld.

K. Butt welds, where authorized, shall have complete penetration and fusion.

L. Finished weld bead shall be central to the seam.

M. Artificial or forced cooling of welded joints is not permitted.

N. Low hydrogen electrode storage shall be in accordance with AWS D1.1 – 5.3.2.1.

O. See District Standard Drawings 323-EA, 324-EA, and 325-EA for welding of flanges.

P. Joining Dissimilar Metals

1. When joining carbon steel to various stainless steels, the following filler material shall be used unless otherwise called out on the drawings:

a. Carbon steel to stainless steel: 309L filler material

b. Carbon steel to type 316 or 316L stainless steel: 309L or 316L filler material

3.2 SUPPLEMENTS

A. The following supplements follow END OF SECTION and are a part of this section:

1. Field Welding Inspection Form

2. Field Welding Submittal Checklist

END OF SECTION

Spec. Number		**Date**	
General Contractor		**Welding Subcontractor**	
Inspection Co		**CWI NAME & #**	

WELDING INSPECTION RECORD

LOCATION DESCRIPTION	*STATION*	*PC MKS*	*DWG DETAIL REF.*	*WELDER ID*	*WPS*	*JOINT FIT-UP AND FIELD TOP*	*ROOT PASS (GROOVE) *FIRST PASS (FILLET)*	*BACK GOUGE VISUAL/NDT*	*FINAL VISUAL*

DESCRIBE ALL IN-PROCESS REWORK: _____

_____

_____

_____

ALL WORK AS LISTED IS IN CONFORMANCE WITH THE CONTRACT DOCUMENTS

FINAL ACCEPTANCE : STAMP / DATE /SIGNATURE	

Sketches:

Field Welding Submittal Checklist

SUBMITTALS TO BE APPROVED PRIOR TO START OF WELDING

Field Pipe Welding (1.5.C) and Structural Welding (1.5.D)	
Description	**Paragraph Reference**
Field Welding Plan	1.4.A
Welding Procedure Specifications for all processes and positions on plan	1.5.A
Procedure Qualification Records (as applicable for above WPS)	1.4.B
Request to witness welder qualification and weld coupon testing (Separate Submittal)	1.5.E
CWI certifications (Separate submittal)	1.4C.1
NDE certifications (Separate submittal)	1.4C.2
Resulting welder/procedure qualification record	1.4.B

Miscellaneous Metals per (1.5.E)	
Description	**Paragraph Reference**
Field Welding Plan	1.4.A
Welder qualification records for all processes and positions on plan including qualification maintenance records for each welding process	1.5D.2
Welding Procedure Specifications for all processes and positions on plan	1.5D.3
Procedure Qualification Records (as applicable)	1.5D.3
CWI certifications (Separate submittal)	1.4C.1
NDE certifications (Separate submittal)	1.4C.2

Notes:

1. Check List is being provided for informational purposes only.

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Includes: Miscellaneous metal fabrications including the following:

1. Miscellaneous metals include stainless steel, and structural steel.

2. Fasteners.

3. Welding.

B. Related Sections:

1. Section 05 05 19 – Anchor Systems

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. A 269 - Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

2. A 276 - Specification for Stainless Steel Bars and Shapes.

B. American Welding Society (AWS):

1. A 5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.

2. A 5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.

3. A 5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.

4. D 1.1, 1.2 & 1.6 - Structural Welding Code – Steel, Aluminum, Stainless Steel.

5. D 10.4 - Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing.

C. Steel Structures Painting Council (SSPC):

1. SSPC SP3 - Power Tool Cleaning.

D. International Conference of Building Officials (ICBO):

1. 2022 California Building Code (CBC).

2. 2021 International Building Code (IBC)

E. Occupational Safety and Health Administration (OSHA).

1.3 SUBMITTALS

A. See contract documents for additional submittal requirements.

B. Shop Drawings: Submit complete fabrication and erection drawings for the Engineer's approval prior to cutting or fabrication. Shop drawings shall show the details of fabrication with weld symbols in accordance with AWS A2.4 for all joints to be welded.

C. Welding Procedures and Certification of Welders:

1. Weld Procedure Specification (WSP) for each type of weld and supporting Procedure Qualification Record (PQR).

2. Submit verifiable evidence of initial qualification for each welder.

3. Submit verifiable evidence each welder has maintained current qualification(s).

4. Provide all submittals at least 10 working days prior to commencing welding except that WPS's and PQR's shall be submitted at least 20 working days prior to welding.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Perform welding of structural metals with welders who have current American Welding Society certificate for the type of welding to be performed.

2. Stainless Steel welding shall conform to ANSI/AWS D16 latest edition - Structural Welding Code-Stainless Steel.

3. Notify ENGINEER 24 hours minimum before starting shop or field welding.

4. ENGINEER may check materials, equipment, and qualifications of welders.

5. Remove welders performing unsatisfactory work, or required them to re-qualify.

6. ENGINEER may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.

7. CONTRACTOR shall bear costs of retests on defective welds.

8. CONTRACTOR shall also bear costs in connection with qualifying welders.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver structural steel free from mill scale, rust, and pitting.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals shall conform with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Stainless Steel		
Plate, sheet and strip	A 240	Type 304L or 316L*
Bars and shapes	A 276	Type 304L or 316L*
Bolts and nuts	F 593	Type 304 or 316*
Nuts	F 594	Type 304 or 316
* Use Type 316L if material will be welded.		

1. Stainless steels are designated by type or series defined by ASTM.

2. Where stainless steel is welded, use low-carbon stainless steel.

2.2 FASTENERS

A. General: Furnish threaded fasteners, except high strength bolts, with flat washers, and self-locking nuts, or lock washers and nuts.

1. Bolt Heads and Nuts: Hex-type.

2. Bolts, Nuts, and Washers: Of domestic manufacture.

3. Where bolts, including anchor bolts, nuts, washers, and similar fasteners are specified to be galvanized, galvanize in accordance with ASTM A153.

B. All Thread Rods and Assembly Bolts

1. Type 316 stainless steel

2.3 MISCELLANEOUS METAL

A. Miscellaneous Stainless Steel:

1. Provide miscellaneous stainless steel items not specified herein as indicated on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine work in place to verify that it is satisfactory to receive the work of this Section. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.2 INSTALLATION

A. General: Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.

B. Welding:

1. AWS D1.6 for stainless steel; type required for materials being welded.

a. An approved submittal on all types of weld connections is required prior to performing any welding.

b. Make welds full penetration type, unless otherwise indicated on the Drawings.

c. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

d. Grind all rough weld beads. Welds exposed to view shall be uniformly neat.

2. Welding Stainless Steel:

a. Perform with electrodes and techniques in accordance with AWS D1.6 and AWS D10.4 as applicable.

END OF SECTION

SECTION 07 21 23

LOOSE-FILL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Perform loose-fill insulation work in accordance with this section, the Drawings, and applicable reference standards listed in Article 1.2.

1. Loose-fill insulation shall include “perlite” and “vermiculite” as defined in PART 2 of this Specification. The main (cylindrical) section of the cold box is filled with perlite and the smaller (rectangular) section is filled with vermiculite.

2. Perlite and vermiculite shall be removed and replaced with new perlite and vermiculite at the Oxygen Production Plant cold boxes number 1 and number 2.

3. Removal, cleaning, and disposal:

   a. Remove and dispose of existing perlite and vermiculite at each cold box. Washdown any perlite and vermiculite and clean each cold box. Allow District up to three weeks to inspect and document conditions in the cold box after Engineer’s acceptance that perlite and vermiculite is sufficiently removed and cleaned.

4. Coordinate work with Mechanical work on LV-330A kettle transfer valve and FV-340N shelf transfer valve inside each cold box in accordance with this section and Specification 40 05 23, Process Valves. Coordinate vermiculite work with replacement of FV-213, FV-214, FV-215, and FV-220.

   a. Perform leak testing of the cold box prior to installation of new perlite and vermiculite insulation. Contractor shall correct any leaks.

5. Supply and installation:

   a. Supply new perlite and vermiculite for each cold box.

   b. Install perlite and vermiculite for each cold box.

1.2 REFERENCES

A. Reference Standards

1. Perlite Institute Designation: 200-77, Loose Weight Determination of Expanded Perlite. See appendix 07 21 23A attached at the end of this Section.

2. Perlite Institute: A Guide for the Bulk Handling of Expanded Perlite (https://www.perlite.org/wp-content/uploads/2018/03/guide-bulk-handling-expanded-perlite.pdf).

3. General Services Administration Specification CID A-A-52450 for Medium Grade 2 Vermiculite

B. Related Sections

1. Document 00 45 13.01 – Supplemental Bidder's Qualifications and References

2. Section 01 14 00 – Work Restrictions

3. Section 01 32 00 – Construction Progress Documentation

4. Section 01 33 00 – Submittal Procedures

5. Section 01 35 13 – Special Project Procedures

6. Section 01 35 24 – Project Safety Requirements

7. NOT USED.

8. Section 01 74 05 – Cleaning

9. Section 01 77 00 – Operational Completion and Project Closeout

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling:

1. Request outages of Oxygen Production Plant equipment and cold boxes in accordance with Section 01 35 13, Special Project Procedures. Submit System Outage Requests (SORs) for each cold box for Engineer's approval.

2. SOR shall be submitted 4 weeks in advance of the scheduled outage.

3. Show SOR submission and review as activities on Contractor's Baseline Construction Schedule in accordance with Section 01 32 00, Construction Progress Documentation. Show all activities associated with removal, cleaning, delivery, and installation of perlite for each cold box respectively and valve work on the Baseline Construction Schedule.

4. Oxygen Production Plant operation shall not be interrupted unless approved in writing by the Engineer through an SOR. The Oxygen Production Plant operates continuously.

    a. Work shall only be performed on an out-of-service cold box. Only one cold box is permitted to be out-of-service at a time.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00, Submittal Procedures.

B. Product Data including manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions.

C. Source and field quality control submittals

1. Material testing data from supplier at least 5 working days prior to delivery.

2. Material testing data of District's six supersacks (sample minimum two supersacks) at least 30 working days prior to start of perlite installation.

3. Field testing data from samples prior to installation.

D. See Document 00 45 13.01, Supplemental Bidder's Qualifications and References for qualification requirements pertaining to work under this specification section.

E. NOT USED.

F. Removal Plan and Installation Plan including methods and equipment to be used.

1. Contractor and any subcontractors involved in work described by this section shall attend two meetings with the District to discuss the Removal Plan and Installation Plan. Initial kickoff meeting may be virtual over Microsoft Teams.

2. Removal Plan and Installation Plan shall be submitted at least 30 working days prior to start of perlite insulation work. Both plans shall describe any coordination activities required with the District.

3. Removal Plan shall describe the means and methods that the Contractor will use to remove the perlite and vermiculite in the cold box, washdown and clean the cold box, safely contain the work area, and dispose of the perlite and vermiculite.

4. Installation Plan shall describe the means and methods that the Contractor will use to install the perlite and vermiculite, including a list of equipment to be used.

G. Perlite and vermiculite disposal plan including landfill name, address and contact information. Submit disposal plan in accordance with Section 01 74 19, Construction Waste Management and Disposal.

H. Closeout and maintenance material submittals in accordance with Section 01 77 00, Operational Completion and Project Closeout.

1.5 QUALITY ASSURANCE

A. Provide in accordance with Section 01 45 00, Quality Control.

B. Qualifications: in accordance with Document 00 45 13.01.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship, store, and handle products consistent with manufacturer recommendations and Perlite Institute: A Guide for the Bulk Handling of Expanded Perlite (see Section 1.2 for website address). Remove defective units from Project Site and replace at no additional cost to the District.

B. District has six supersacks of perlite insulation from 2019 containing approximately 240 cubic feet of perlite. Contractor shall test perlite from the supersacks and submit testing results to the District at least 30 working days prior to the start of perlite installation for either cold box. If District approves of the test results, Contractor may use competent perlite from the supersacks as top-off.

C. Staging area: per Drawings.

1. Additional staging area: as approved by District.

D. Provide all equipment, labor, and inspection necessary to handle the perlite and vermiculite delivered to the jobsite. Contractor is responsible for any associated costs for handling the insulation material. Properly dispose of any materials, equipment, and ancillary packaging remaining at the completion of work not handed off to the District. Dispose of the District's six supersacks if unused.

1.7 SITE CONDITIONS

A. Existing conditions: see Sections 01 11 00, Summary of Work and 01 14 00, Work Restrictions. Stage material only in authorized staging areas.

1.8 SPARE PARTS

A. Furnish extra materials as specified herein. Make interchangeable with and of same material and workmanship as corresponding original parts.

B. NOT USED.

C. Volume of perlite provided shall be measured as the actual volumetric quantity of insulation media filling the space of the cold box after installation. Volume shall not be based on supersack capacity.

PART 2 - PRODUCTS

2.1 LOOSE-FILL INSULATION - PERLITE

A. Comply with applicable reference standards listed in Article 1.2.

1. Provide cryogenic-grade low-density expanded perlite insulation suitable for use in Praxair U-125 oxygen production plants.

2. Tests shall be performed in accordance with Perlite Institute Designation: 200-77, Loose Weight Determination of Expanded Perlite prior to installation. Material that does not conform to these Specifications shall be rejected.

3. Test each batch of perlite in accordance with the following. A batch of perlite shall be defined as having been manufactured at the same time (within a month) and location. Provide test results for a one cubic foot sample of each batch unless otherwise approved by the Engineer.

   a. Grain size: ASTM E11, Standard Specification for Woven Wire Cloth and Test Sieves.

   b. Combustibility: in accordance with this section.

   c. Solvent Solubles: in accordance with this section.

B. Design/Performance Criteria

1. Compacted density of material: maximum 5.7 lbs/ft^3.

2. Total weight loss of material when heating at 221 degrees F for two hours: less than 1.0%.

3. Thermal conductivity at mean temperature of -195 degrees F: maximum 0.20 BTU in/h ft^2 degrees F.

4. Material properties

   a. Substantially free of organic material

   b. Combustibility: Does not spark or burn when in contact with embedded glowing platinum wire in 100% oxygen atmosphere at 14.7 psia

c. Solvent Solubles: Does not contain more than 1% by weight of matter that is soluble in n-propylbromide

5. Grain size: within limits as follows.

Standard Sieve Size	Cumulative % Retained (by weight)	
	Max.	Min.
No. 16 (1180 µm)	10	0
No. 30 (600 µm)	40	15
No. 100 (150 µm)	100	50

C. Perlite and vermiculite Maintenance (Removal and Cleaning)

1. A&B Transport, Inc.

2. Pennsylvania Perlite Corporation.

3. Or equal.

D. Perlite and vermiculiteSuppliers

1. A&B Transport, Inc.

2. Pennsylvania Perlite Corporation.

3. CryoPerl.

4. Or equal.

2.2 SOURCE QUALITY CONTROL

A. Comply with applicable reference standards listed in Article 1.2.

B. Submit the results of material testing by an independent materials testing laboratory of a one cubic foot sample of the perlite material. The materials testing laboratory shall be accredited by the American Association for Laboratory Accreditation (A2LA).

2.3 LOOSE-FILL INSULATION - VERMICULITE

A. Comply with applicable reference standards listed in Article 1.2.

B. Material properties

1. Substantially free of organic material

2. Combustibility: Does not spark or burn when in contact with embedded glowing platinum wire in 100% oxygen atmosphere at 14.7 psia

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to performing Work, conduct Safety Tailgate meeting with on-site personnel. Coordinate Lock Out Tag Out (LOTO) of cold box with District Staff.

B. Prepare a Job Hazard Analysis (JHA) Report in accordance with Section 01 35 24, Project Safety Requirements for District review and approval prior to performing the work.

C. Complete Work in compliance with applicable requirements in Title 8, California Code of Regulations (Cal/OSHA) and Specification Section 01 35 24, Project Safety Requirements.

1. Contractor shall submit a job hazard analysis (JHA) for District review prior to start of work.

2. The cold boxes are classified as a Confined Space and shall be treated as such throughout duration of the Work. Test internal atmosphere with hand-held oxygen or multi-gas monitor prior to entry to ensure safe level of oxygen is present. Implement and maintain effective mitigation, monitoring, and rescue (as applicable) measures for the duration of the Work.

3. During normal operation, equipment inside a cold box operates under pressure from one or more large, connected main air compressors. Source air shall be valved out and locked out prior to start of Work. During cold box leak testing, main air compressors will need to be valved in and cold box will be pressurized.

4. The Contractor shall use code compliant fall protection systems or provide scaffolding when working at heights greater than six feet at a cold box. A y-harness is required to use the existing ladders.

D. Cold Box Preparation

1. A cold box will be taken out of operation and warmed to ambient temperature by others prior to start of Work.

a. Take cold box out of service at least 15 days prior to start of Work to reduce risk of encountering frozen perlite or residual liquid.

b. Submit SOR 4 weeks in advance of planned outage.

2. If manway is opened, lean the surrounding area.

3.2 REMOVAL AND DISPOSAL OF EXISTING PERLITE AND VERMICULITE

A. Removal of perlite and vermiculite and cleaning of the cold box shall be performed by a firm meeting the requirements for Removal and Disposal in accordance with Document 00 45 13.01, Supplementary Bidder's Qualifications and References.

If manway at bottom of cold box is opened, open slowly to avoid damaging equipment. Insert vacuum hose into manway and remove residual perlite and vermiculite to ensure that the cold box is completely free of residual perlite and vermiculite.

B. Sweep down and wash out residual perlite and vermiculite from cold box. Achieve 100% removal of existing perlite and vermiculite, including top surfaces of equipment and piping and around flanges and bolts.

1. Use potable water to wash down interior of cold box to remove any residual perlite and vermiculite and dust.

2. Provide necessary hoses and fittings to connect to potable water source.

3. Restrict flow of wash-down water to avoid damaging cold box piping, equipment, and wiring. Repair any damaged piping, equipment or wiring at no additional cost to the District.

4. Contractor is responsible for disposal of wash-down water. Contractor may discharge wash-down water to MWWTP catch basin within staging area after treating with a 200-micron or finer sock filter.

C. Inspection and Acceptance of Cleaned Cold Box

1. Provide minimum one week notice to Engineer to arrange for inspection and leak testing of internal cold box components. Once cleaning operations are complete, enter cold box and video record conditions and submit recording for District's records. Correct unsatisfactory cleaning Work at no additional cost to the District.

a. Allow the District at least three weeks for its inspection of the cold box. Provide equipment to facilitate confined space entry and safe entry for District staff during its inspection of the cold box.

D. Dispose of removed perlite and vermiculite in accordance with Section 01 35 44, Environmental Requirements.

3.3 LOOSE-FILL INSULATION INSTALLATION

A. Supplier of perlite and vermiculite in the cold boxes shall meet the requirements for Supply in accordance with Document 00 45 13.01, Supplementary Bidder's Qualifications and References.

B. Installation of perlite and vermiculite in the cold boxes shall be performed by a firm meeting the requirements for Installation in accordance with Document 00 45 13.01, Supplementary Bidder's Qualifications and References.

C. Commence installation of perlite and vermiculite after Engineer approves all interior cold box work, and after completion of valve work inside the cold box.

D. Fill all voids within cold box and to within 6-inches of roof with perlite and vermiculite.

E. At any stage during the perlite and vermiculite installation, District may vibrate the cold box by throttling the make/fill valves, starting-up the out-of-service plant, or knocking on the cold box walls to check that the perlite and vermiculite is properly packed and that there are no voids. Contractor shall continue to fill any voids and top off the cold box until the perlite and vermiculite level no longer changes after vibration.

3.4 FIELD QUALITY CONTROL

A. Provide in accordance with Section 01 45 00, Quality Control.

3.5 CLEANING

A. Clean jobsite in accordance with Section 01 74 05, Cleaning after perlite and vermiculite insulation is installed for each cold box. Clean up spilled insulation material. Leave site broom clean.

END OF SECTION

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SUPPLIER'S CERTIFICATE OF PROPER INSTALLATION

This is to certify that the perlite supplied by the SUPPLIER has been installed in accordance with supplier's recommendations. The perlite was inspected by an authorized supplier's representative on _____ (DATE) and has been tested and found to be in conformance with these Specifications. All reports have been submitted to the District and cold box #_____ is certified for field testing and startup in accordance with Specification SD-428 Main Wastewater Treatment Plant Oxygen Plant Rehabilitation, Section 01 75 17 Field Testing and Startup.

Authorized Supplier's Representative		Contractor's Representative	
Title	Date	Title	Date

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SECTION 07 21 23A

LOOSE-FILL INSULATION
PERLITE INSTITUTE DESGINATION: 200 – 77

PART 1 - GENERAL

1.1 SCOPE

A. This method covers the determination of the loose weight of expanded perlite.

1.2 REFERENCES

A. Reference Standards

1. Perlite Institute Test Methods and Related Standards.

PART 2 - NOT USED.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Apparatus:

1. Shovel or scoop.

2. Calibrated metal, cylindrical measure of 1-2 liter capacity.

3. Balance of scale sensitive to within 0.1 percent of sample weight to be tested.

3.2 PROCEDURE

A. The measure shall be filled to overflowing by means of a shovel or scoop, the perlite being discharged from a height of not to exceed 50 mm above the top of the measure. Care shall be taken to prevent, so far as possible, segregation of the particle sizes of which the sample is composed.

B. The surface of the perlite shall then be leveled off with a straight edge.

C. The net weight of the perlite in the measure shall be determined.

3.3 UNIT CONVERSION

A. The loose weight in kg/m^3 is determined as equal to:

$$\frac{weight\ of\ perlite\ sample\ (in\ grams)}{volume\ of\ perlite\ sample\ (in\ milliliters)}\ x\ 1000$$

B. The loose weight in lb/ft^3 is determined as equal to:

$$\frac{weight\ of\ perlite\ sample\ (in\ grams)}{volume\ of\ perlite\ sample\ (in\ milliliters)}\ x\ 62.4$$

END OF SECTION

SECTION 09 90 00

PAINTING AND COATINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Surface preparation, furnishing, and application of paint and special protective coatings, complete. Surfaces to be painted includes all metallic surfaces within the extent of work, as indicated on the Contract Drawings, except for surfaces specifically noted to remain unpainted by these Specifications. Coatings work includes but is not limited to:

   a. Cold box No. 1 and No. 2 as shown on the Drawings.

2. For all cold box and turbine duct assemblies to be recoated, clean surfaces to bare metal in accordance with SSPC-SP 6. Apply primer, intermediate, and topcoat as specified within. Protect any surfaces not to be painted. Contractor shall recoat any surfaces it damages in accordance with these Specifications.

3. The Contractor shall perform all painting and coatings work in accordance with applicable local, state and federal requirements.

4. Refer to Article 2.2 – PAINTING AND COATING SYSTEMS for a list of coating systems and Article 3.3 – COATING SYSTEM APPLICATION SCHEDULE for the locations where they are to be applied.

5. NOT USED.

B. Related Sections

1. Section 01 35 24 – Project Safety Requirements

2. Section 01 35 44 – Environmental Requirements

3. Section 01 91 13.10 – Asset Identification Tags

4. Section 02 83 13 – Lead Hazard Control Activities

5. NOT USED

1.2 ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
CSP	Concrete Surface Profile
FRP	Fiberglass Reinforced Plastic
HC 1	Hydrochloric Acid
ICRI	International Concrete Repair Institute
MC	Methylene Chloride
MDFT	Minimum Dry Film Thickness
MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
MIL-P	Military Specification – Paint
NACE	National Association of Corrosion Engineers
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
PVC	Polyvinyl Chloride
SFPG	Square Feet Per Gallon
PVDF	Polyvinylidene Fluoride
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.3 REFERENCES

A. American Society of Testing Materials (ASTM) standards

B. International Concrete Repair Institute (ICRI) standards

C. Steel Structures Painting Council (SSPC)

1. SSPC Vol. 1, Steel Structures Painting Manual, Volume 1, Good Painting Practice.

2. SSPC Vol. 2, Steel Structures Painting Manual, Volume 2, Systems and Specifications.

3. SSPC-SP 1 Solvent Cleaning.

4. SSPC-SP 3 Power Tool Cleaning.

5. SSPC-SP 5/NACE No. 1 White Metal Blast Cleaning.

6. SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning.

7. SSPC-SP 10/NACE No. 2 Near White Blast Cleaning.

8. SSPC-SP 11 Power Tool Cleaning to Bare Metal

9. SSPC-SP 16 Brush-Off Blast Cleaning Non-Ferrous Metals

10. SSPC-PA 1 Shop, Field, & Maintenance Painting

11. SSPC-PA 2 Measurement of Dry Paint Thickness with Magnetic Gages

12. SSPC-PA Guide to Safety in Paint Application Guide 3

13. SSPC-VIS 1 Pictorial Surface Preparation Standards for Painting Steel Surfaces

14. SSPC-A31 Mineral and Slag Abrasives

15. SSPC-WJ 4/NACE WJ 4 Light Water jetting

16. SSPC Surface Preparation Commentary for Metal Substrates

D. National Association of Corrosion Engineers (NACE) standards

1. SP0892-2007 - Coatings and Linings over Concrete for Chemical Immersion and Containment Service.

1.4 PERFORMANCE REQUIREMENTS

A. Coating for final coats shall be fume resistant, compounded with pigment suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Coating material shall be able to handle harsh abrasives such as sand and grit.

B. Pigments shall be materials that do not darken, discolor, or fade due to action of sewage gases.

1.5 SUBMITTALS

A. See Sections 01 35 24 – Project Safety Requirements and 01 35 44 – Environmental Requirements.

1. Submit noise abatement plan. Contractor’s work activities shall not generate noise exceeding 90 dB beyond 20 feet from either cold box. Contractor’s work shall not generate noise exceeding 100 dB around the Oxygen Plant work area. Contractor shall provide noise protection for District staff entering the work area during noise intensive activities and post signs at entrances to the work area providing guidance on hearing protection. Contractor shall observe OSHA’s guidelines for permissible noise exposure limits and durations.

2. Provide written notice to the Engineer at least ten (10) working days in advance of any noise intensive activities.

B. Containment Plans

1. The Contractor shall provide a containment plan conforming to SSPC Guide 6 Class 2A, with flexible containment materials and a rigid support structure for areas that require abrasive blast surface preparation. The Contractor shall provide a containment plan for all other areas conforming to SSPC Guide 6 Class 2W, with flexible containment materials and a rigid support structure. The containment plans shall include drawings, equipment specifications, and calculations for wind load. The containment plans shall be stamped by a civil or structural engineer registered in the State of California. The plans shall also include copies of the manufacturer's specifications for containment materials and equipment that will be used for containment activities.

2. The Contractor shall provide ambient air monitoring for toxic metals during abrasive blasting activities in accordance with the section herein and with Section 02 83 13, Lead Hazard Control Activities. The Contractor shall monitor ambient air in accordance with SSPC-TU 7, Method D: Ambient Air Monitoring for Toxic Metals (TSP Lead). Daily reports shall be made available to the Engineer for review.

    a. For dry abrasive blasting, monitoring shall be conducted during all days of dust-producing activities.

    b. For wet abrasive blasting, monitoring shall be conducted for the first 3 days of dust producing operations. If the results after 3 days are acceptable, monitoring may be discontinued.

    c. Background samples shall be collected for 2 days prior to the start of work while no dust producing operations are underway to provide a baseline. The monitoring shall coincide with anticipated working hours of coatings removal activities.

3. The Containment plan shall also describe treatment, removal, and/or disposal of debris and process (spent) water generated from blasting activities. Contamination of adjacent areas due to leaks or a breach of the Contractor's containment setup shall be cleaned up and restored at the Contractor's expense.

C. Product Data: Furnish the following:

1. Data Sheets:

    a. For each paint system used herein, furnish

        1) Paint System Data Sheet. A sample PSDS form is appended to the end of this section.

        2) Technical Data Sheets – Including:

            a) Solids Content

b) Ingredient analysis

c) VOC content

d) Chemical resistance

e) Temperature resistance

f) Typical exposures and limitations

b. Manufacturer's Instructions including:

1) Special requirements for transportation and storage

2) Mixing instructions

3) Shelf life

4) Pot life of materials

5) Precautions for application free of defects

6) Surface preparation

7) Transition between existing coating (top half of cold box) and new coating

a) Contractor shall provide Manufacturer's written confirmation that new coating is compatible with existing coating. See Appendix B for literature on the existing coating: Sherwin Williams Hi-Solids Polyurethane 250.

b) Include specific instructions from Manufacturer's representative on surface preparation where the new coating meets the existing coatings (i.e. feather edges, method used).

8) Method of application

9) Recommended number of coats

10) Recommended thickness of each coat

11) Recommended total thickness

12) Drying time for each coat, including prime coat

13) Required prime coat

14) Compatible and non-compatible prime coats

15) Recommended thinners, when recommended

16) Limits of ambient conditions during and after application

17) Time allowed between coats

18) Required protection from sun, wind, and other conditions

19) Touch-up requirements and limitations

c. Paint colors available for each product used.

d. Maintenance & Repair Instructions

e. Regulatory Requirements: VOC compound limitations, coatings containing lead compounds, abrasive, abrasive blast cleaning techniques, and disposal.

f. Indiscriminate submittal of manufacturer's literature only is not acceptable.

2. Alternate Paint Systems: Furnish information as required for specified products if proposing to furnish alternate products.

3. Furnish manufacturer's written instructions for applying each type of paint or protective coating prior to application.

4. Also provide copies of paint system submittals to the coating applicator.

D. Samples:

1. Prior to procurement of coatings, furnish minimum 4- by 4-inch samples with type of paint and application specified on similar substrate to which paint is to be applied for Engineer’s approval.

2. Furnish additional samples as required until colors, finishes, and textures are approved by the Engineer.

3. Retain approved samples to be used as the quality standard for final finishes.

E. Quality Control Submittals:

1. Applicator's Experience: List of references substantiating the requirement as specified.

2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified herein.

3. If the manufacturer of finish coating differs from that of shop primer, provide manufacturer's written confirmation that materials are compatible.

4. Adhesion test documentation as applicable.

F. Substitute or “Or Equal” Submittals: Unless otherwise specified, materials shall be from catalogs of the companies listed herein. Materials from other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed. The Contractor shall provide satisfactory proof from the firm manufacturing the proposed substitution.

1.6 QUALITY ASSURANCE

A. The paint manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.

B. Applicator's Experience: Minimum 5 years' practical experience in application of specified products.

C. Applicator’s Certification: Applicator shall have an active C-33 (Painting and Decorating Contractor) license from the Contractors' State License Board at the time of bid submission, which must remain valid throughout the duration of the contract.

D. Standardization: Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.

E. Testing:

1. Magnification: The Engineer may use magnification to 8 power in the inspection of surface preparation and coatings however, the Engineer is not limited magnification to 8 power.

2. Destructive testing of coating: Engineer may use destructive test instruments to analyze coating failures.

F. Mockup:

1. At least two weeks prior to painting work for each cold box, provide a minimum 8- by 10-inch mockup of the approved paint and application specified on similar substrate in the presence of the Engineer to check the paint system performance, quality, thickness, and color.

   a. Perform dry-film thickness and adhesion testing on the mockup.

2. Acceptance of the mockup does not constitute approval of deviations from the Contract Documents.

G. Contractor's Third-party Inspection:

1. Hire an independent third-party Coating Inspection firm who shall provide a NACE Level II inspector to conduct required inspections and continuously observe performance of coating procedures, testing and final inspection. The work of the NACE Level II inspector shall be supervised by a NACE Level III inspector.

2. Contractor shall ensure that NACE III supervisor will provide no less than 4 hours per month at the jobsite providing field supervision and oversight of Contractor's NACE II inspector throughout the entire duration of the construction work.

3. Prior to the start of any work, the Contractor shall establish with the Engineer, schedules and notification procedures that will ensure that all surface preparation work has been inspected prior to the application of any coating. These procedures shall remain in effect for the duration of the project. Under no circumstances shall any surfaces be coated without prior approval of the Engineer. Coatings applied without the Engineer's authorization shall be removed and reapplied at the sole expense of the Contractor. Log sheets, approved by the Engineer, shall be used as the permanent record of all inspections with copies forwarded to the Engineer daily.

4. The Contractor shall maintain an accurate, written record of the quantity of coating material applied and the corresponding surface area covered, a description of the area coated the batch number, surface temperature, ambient temperature, relative humidity, dew point, and applicator on a daily basis. The Contractor shall furnish a signed copy of said record to the Engineer and upload the records to the Construction Management Information System (CMIS). These quantities will be independently verified by the Engineer and reported on the Engineer's log. The Engineer shall immediately investigate and resolve any discrepancies between these reported quantities. The Contractor's third-party Inspector shall test the completed coating application.

1.7 WARRANTY

A. The warranty period of Article 10, Warranty, of the General Conditions, shall be five years for defects of material and workmanship for the work of this Section 09 90 00 Painting and Coatings.

B. Warranty inspections shall be conducted in Years 1 and 5 following work acceptance. Separate warranty inspections will be conducted for each cold box and their associated equipment.

1. District will establish date of inspection and will notify Contractor at least 30 days in advance of inspection.

2. Contractor may elect to be present during inspection.

C. Inspection Report: Engineer will prepare and deliver to the Contractor a report of the warranty inspection. The report will set forth the number and type of failures observed, the percentage of the surface area where failure has occurred, and the names of persons making the inspection.

D. Failure: any location where coating has delaminated, peeled, blistered, or cracked; and any location where rusting is evident will be considered a failure of the coating system.

E. Remedial Work: The Contractor, at no additional cost to the District, shall perform all work and supply all equipment and materials associated with the repair of failures identified in the warranty inspection. Repair all failures by removing the deteriorated coating, cleaning the surface, and recoating with the same system in accordance with this Section and with the manufacturer's recommendation. Surface preparation of all failures shall be to SSPC-SP 6.

F. Extensive Failure: If the area of failure exceeds 25 percent of an individual cold box, turbine duct assembly, or other associated O2 Plant equipment to be coated, then that facility shall be recoated in accordance with this Section.

G. Schedule of Remedial Work: The Engineer will establish a starting date and a reasonable time of completion for remedial work. The starting date will be not less than 30 days after delivery of the warranty inspection report to the Contractor. Should the Contractor fail to start the remedial work within ten days after the starting date established by the Engineer, the District may at its option perform the remedial work, and the Contractor shall pay to the District the actual cost of such work plus 20 percent.

H. Extended warranty: All remedial work performed shall be guaranteed under terms of Article 10, Warranty, of the General Conditions for defects of material and workmanship for two years from completion of the remedial work.

1. The District may conduct a first anniversary warranty inspection of remedial work and require repair of failures under the terms of this Article.

I. Cost of Inspection: The first and fifth anniversary warranty inspections will be at the expense of the District. Warranty inspections of remedial work shall be at the expense of the Contractor.

1.8 PAINT DELIVERY, STORAGE, AND HANDLING

A. Deliver paint to project site in unopened containers that plainly show, at time of use, the designated name, date of manufacture, color, and name of manufacturer.

B. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by paint manufacturer.

C. Shipping:

1. Where pre-coated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.

2. Use nonmetallic or padded slings and straps in handling.

3. Items will be rejected for excessive damage.

PART 2 - PRODUCTS

2.1 GENERAL

A. Primer, intermediate, and finish coats shall be of same manufacturer.

B. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Products shall comply with Bay Area Air Quality Management District Regulation 8 Rule 3. Specific information may be secured through the office of the BAAQMD.

C. Coatings in contact with potable water shall be certified by the National Sanitation Foundation in accordance with ANSI/NSF Standard 61.

D. Coating systems also apply to recoating of existing surfaces if specified to be recoated on the Drawings and/or in this specification.

E. Coating systems also apply to recoating of existing surfaces if specified to be recoated on the Drawings and/or in this specification.

F. Formulate with colorants free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gases at the project site.

2.2 PAINTING AND COATING SYSTEMS

A. Generic coating systems, film thickness, and surface preparation requirements are shown as follows. Specific surface preparation and coating system for each item or area shown on drawings or specified in other specifications sections shall be submitted for review using specified Paint System Data Sheet.

2.3 PAINTING AND COATINGS MATERIALS

A. District-accepted manufacturer’s materials (or Equal) shall be used for the Painting and Coating Systems per Table 2.

B. Thinners and solvents as specified by the coating system manufacturer

Table 1. System Coatings

System No.	Paint Materials (Each line indicates one coat)	Required # of Coats, Min. Cover (MDFT)	Surface Prep.
1	NOT USED		
2	Urethane Based Zinc-Rich (Prime)	1 coat, 3-6 mil	SSPC SP-6
	Epoxy, Atmospheric (Intermediate)	1 coat, 4-6 mil	
	Polyurethane, Aliphatic (Finish)	1 coat, 3-5 mil	
3	NOT USED		
4	NOT USED		
5	NOT USED		
6	NOT USED		
7	NOT USED		
8	NOT USED		
9	NOT USED		
10	NOT USED		
11	NOT USED		
12	NOT USED		
13	NOT USED		
14	Epoxy, Atmospheric (Prime)	1 coat, 4-6 mil	SSPC-SP 6
	Polyurethane, Aliphatic (Finish)	1 coat, 4-6 mil	

Table 2. Paintings and Coatings Materials

	Sherwin Williams
Urethane Based Zinc-Rich, Primer	Corothane Galvapac One Pack Zinc Primer CA
Epoxy, Atmospheric	Macropoxy 646
Polyurethane, Aliphatic	High Solids Polyurethane - 250

2.4 COLORS

A. Equipment Colors:

1. For the top coat of both cold boxes and turbine duct assemblies, Contractor shall match the existing color of the cold boxes beginning 12 feet above finish floor (upper portion of the cold box towers). Contractor shall verify the existing color in field based on the upper portions of the cold box towers.

2. For the top coat of other cold box area equipment and supports, Contractor shall use popcorn (white). Contractor shall verify the color in field based on the air surge tank.

3. Contractor shall perform a site walk with the Engineer to coordinate the color for items to be coated or recoated in the cold box area before ordering paint.

4. Contractor shall use a different paint color for each adjacent layer of paint if the products used are different.

5. For reference only, the Sherwin Williams color codes (2019) for the upper half of each cold box are:

    a. Macropoxy 646 – color CCC0471-15

    b. High-solids polyurethane 250 – color CCC0473-15

PART 3 - EXECUTION

3.1 GENERAL

A. Surface Preparation Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.

2. Provide District inspector opportunity to inspect all surfaces following cleaning, abrasion or surface preparation but prior to application of coatings.

3. Provide District minimum 10 days advance notice prior to start of surface preparation work, and 3 days minimum advance notice prior to start of coating application work.

4. Perform such work only in presence of District, unless District grants prior approval to perform such work in District's absence.

5. Cleaned surfaces shall be tested for soluble salts prior to the application of coatings. Chloride levels shall be 10 $\mu g/cm^2$ or less as determined using the “Chlor-test” method for chlorides or engineer approved equivalent. At least 3 tests shall be performed on each cold box and turbine ductwork assembly. If any single test is greater than 10 $\mu g/cm^2$, those structures shall be re-cleaned.

B. Mix and apply all coatings in accordance with the manufacturer’s instructions, the applicable requirements of SSPC-PA 1, and as specified herein.

C. Do not apply paint in temperatures exceeding manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

D. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.

E. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats, and within curing time following application of last coat.

F. Provide adequate continuous ventilation and sufficient heating facilities to maintain a minimum of 45 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

G. After award of contract, Contractor, and its coating subcontractor, shall attend a pre-job meeting at the job site prior to starting work or purchasing coating materials.

3.2 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown, the following areas or items will not require painting:

1. Nonferrous and corrosion-resistant ferrous alloys such as bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:

a. Required for electrical insulation between dissimilar metals

b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.

2. Glass and porcelain

3. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panel boards, transformers, disconnect switches, building louvers, wall panels, etc.; color coding of equipment is required.

4. Non-submerged electrical conduits attached to unpainted concrete surfaces

5. Flexible Tubing (Tygon)

6. Stainless steel tubing

7. Copper tubing not currently coated.

8. Pipe and bolt threads

B. Manufactured items and materials that are "factory" galvanized or existing galvanized surfaces shall be coated as specified hereinafter for the exposure condition of the item and for architectural purposes, unless specified herein.

C. HDPE Pipe

D. Protection of materials not to be painted:

1. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

2. Provide drop cloths, shields, scaffolding, barriers and protective methods to prevent paint materials from falling on or marring adjacent surfaces.

3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

4. Mask openings in motors to prevent paint and other materials from entering the motors.

5. Protect gauges, gaskets, and other sensitive equipment from damage from pressure washing.

3.3 COATING SYSTEM APPLICATION SCHEDULE

A. General:

1. Coat all exposed surfaces as shown in Table 4. Ensure surface preparation conforms to these specification requirements and are compatible with field applied finish coats.

2. The equipment and materials listed in Table 4 under each category are included to provide clarity for each category; however, they are only examples and all surfaces which meet the category shall be coated with the specified System.

3. Refer to drawings and specifications for existing surfaces requiring recoating.

3.4 RECOATING OF EXISTING COATED SURFACES

A. Existing coated surfaces requiring recoating, as indicated in Drawings or Specifications, shall be recoated per the requirements of this Specification.

B. Surface preparation of existing coated surfaces requiring recoating shall conform to the requirements of Article 3.7 C of this Specification.

C. All exposed existing coated surfaces requiring recoating shall be coated with the system indicated in Table 4.

Table 3. System Coatings Execution

Surface /Location	Exposure	Interior /Exterior	Coating System	Example Locations
Metal	Not Typically Subject to Submersion	Exterior to Structures, Tanks and Basins (exposed to weather)	System 2	Existing coated surfaces as indicated in Contract Drawings, including but not limited to the lower portion of cold box no.1, cold box no. 2, and turbine duct assemblies.
Metal	Not Typically Subject to Submersion or corrosion	Exterior to Structures, Tanks and Basins (exposed to weather)	System 2	Existing coated surfaces as directed by the Engineer in the cold box area
Galvanized Surfaces and Non-Ferrous Metal (As indicated on drawings)	Not Typically Subject to Submersion or corrosion	Exterior to Structures, Tanks and Basins (exposed to weather)	System 14	Existing coated galvanized surfaces as indicated in Contract Drawings

3.5 APPLICATION SAFETY

A. Perform painting in accordance with recommendations of the following:

1. Paint manufacturer's instructions.

2. NACE, contained in the publication, Manual for Painter Safety

3. Federal, state, and local agencies having jurisdiction

3.6 PAINT MIXING

A. Multiple-Component Coatings:

1. Prepare using all the contents of the container for each component as specified and packaged by paint manufacturer. No partial batches will be permitted.

2. Do not use multiple-component coatings that have been mixed beyond their pot life.

3. Provide small quantity kits for touchup painting and for painting other small areas.

4. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Keep paint materials sealed when not in use.

C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.7 PREPARATION OF SURFACES

A. GENERAL

1. Prepare surfaces per manufacturer’s recommendation.

B. Metal Surface Preparation:

1. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current SSPC Specifications as follows:

a. Solvent Cleaning: SP 1.

b. Hand Tool Cleaning: SP 2.

c. Power Tool Cleaning: SP 3.

d. White Metal Blast Cleaning: SP 5/NAC No. 1.

e. Commercial Blast Cleaning: SP 6/NACE No. 3.

f. Brush-Off Blast Cleaning: SP 7/ NACE No. 4.

g. Pickling: SP 8.

h. Near-White Blast Cleaning: SP 10/NACE No. 2.

i. Power Tool Cleaning to Bare Metal: SP 11

j. Light Water jetting: SP WJ-4

2. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.

3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.

5. Repair defects deeper than 12.5% of nominal thickness of steel by repair welding and grinding smooth.

C. Preparation of Existing Coated Surfaces:

1. All surfaces to be repainted: Pressure wash clean all surfaces per SP WJ-4 to remove all chalking and loose paint with the use of a biodegradable cleaner. Pressure washing pressure shall not exceed 5,000 PSI.

2. All previously coated and existing painted surfaces shall be thoroughly and completely abraded with 80 grit sandpaper. Existing coatings shall be sufficiently deglossed and profiled for application of prime coats.

3. Clean loose, abraded, or damaged coatings to substrate by Hand or Power Tool, SP 2 or SP 3.

4. All corroded surfaces shall be mechanically cleaned per SP 11 to remove all corrosion or deteriorated material.

5. Feather surrounding intact coating.

6. Apply one spot coat of the specified primer to bare areas, overlapping prepared existing coating a minimum of one inch.

7. Apply one full intermediate and finish coat of the specified coats overall.

8. If an aged, plural-component material is to be top-coated, contact coating manufacturer concerned for additional surface preparation requirements.

D. Pre-Blast Cleaning Requirements:

1. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

2. Cleaning Methods: Steam, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.

3. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.

4. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

5. Welds and Adjacent Areas:

a. Prepare such that there is: No undercutting or reverse ridges on weld bead. No weld spatter on or adjacent to weld or any other area to be painted. No sharp peaks or ridges along weld bead.

b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

E. Blast Cleaning Requirements:

1. Meet applicable federal, state, and local air pollution and environmental control regulations for aggregate types, blast cleaning procedures and disposition of spent aggregate and debris.

2. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.

3. Use only dry blast cleaning methods unless an approved abrasive recycling system is used that removes debris and spent abrasive.

4. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness.

F. Post-Blast Cleaning and Other Cleaning Requirements:

1. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

2. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted.

G. Field Sandblasting:

1. Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures shall meet requirements of Steel Structures Painting Council.

3.8 APPLICATION OF PAINT

A. General:

1. Inspection: Schedule with District in advance for cleaned surfaces and all coats prior to succeeding coat.

2. Apply coatings in accordance with paint manufacturer's recommendations, including environmental controls, product handling, mixing, application equipment, and coating methods. Allow sufficient time between coats to assure thorough drying of previously applied paint.

3. Coating shall interface with adjoining construction materials/components to effectively seal and protect the substrate.

4. Stripe coat all angles, edges and welds in tanks and highly corrosive atmospheric exposure before applying specified painting system.

5. Apply all coatings by airless spray or roller except:

a. Plural component spray systems and/or dual component spray systems will not be permitted.

b. Areas of less than 36 square inches may be brushed.

c. Required brush striping of repairs, welds, nuts, bolts, and edges. Do not thin.

6. Verify spray equipment is in working order and can accurately ratio and apply the coating product.

7. Verify only applicators meeting the proper quality assurance requirements are performing all aspects of the coating work.

B. Film Thickness:

1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.

2. Number of Coats: Minimum required irrespective of coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

3. Maximum film build per coat shall not exceed coating manufacturer's recommendations.

4. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.

5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

6. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

7. All coats are subject to inspection by the District or a District designated representative.

8. See Quality Control section below for Thickness Testing.

C. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.

2. Repair fusion bonded coatings as recommended by original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by coating manufacturer.

3. Apply finish coats, including touchup and damage-repair coats in a manner which will present a uniform texture and color-matched appearance.

D. Unsatisfactory Application:

1. If item has an improper finish color, or insufficient film thickness, clean and top coat surface with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.

3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.

4. Repair defects in coating system per written recommendations of coating manufacturer.

3.9 QUALITY CONTROL

A. Measure relative humidity and metal surface temperature and determine dew point each day prior to painting. Repeat measurements as often as the District deems necessary but not less often than every four hours.

1. The District will also measure relative humidity and metal surface temperature and determine dew point at least once each day that painting is performed.

B. The District will evaluate surface preparation using SSPC-VIS 1 and replica tapes. Evaluation of cleanliness will be made immediately prior to coating application.

C. Verify cleanliness of all spray application equipment prior to, or no later than, time of mixing coating material.

D. District will evaluate cleanliness of coated surface immediately prior to application of a subsequent coat.

E. Leave all staging up until District has inspected surface or coating. Replace staging removed prior to approval by District.

F. Film Thickness Testing and Electrical Inspection of Coated Surfaces:

1. Perform with properly calibrated instruments.

2. Recoat and repair as necessary for compliance with the Specifications.

3. Measure coating thickness after each coat using non-destructive magnetic dry film gauges

a. Measure in accordance with SSPC-PA 2

b. District will also measure coating thickness, at random locations, after each coat.

4. Repair areas not meeting thickness requirements per Application Section above. Retest after coating repairs.

G. Holiday Testing

1. Contractor shall test all coated surfaces for pinholes and holidays after application of the final coat.

2. Perform test in presence of the District.

3. Perform test after coating has cured per manufacturer's recommendation.

4. As directed by the District, use either a low voltage wet sponge holiday detector or a high voltage holiday detector.

    a. Low voltage wet sponge holiday detector shall be equal to K-D Bird or Tinker & Rasor M-1. Add a non-sudsing wetting agent, such as Eastman Kodak Photo-Flo to the water used to saturate the sponge.

    b. High voltage holiday detector shall be equal to Tinker & Rasor AP-W or D. E. Stearns Model 14/20, for coatings greater than 20-mil thickness. Use in accordance with coating manufacturer's recommendations except use voltage of 150 volts per mil of coating.

    c. Repair holidays per Application Section above. Retest after coating repairs.

H. Adhesion Test for determining Compatibility of New Paint over Existing Paints

1. Before recoating any existing coated surface, determine the compatibility of new paint over existing paints as specified here.

2. Select a minimum of three representative areas on surface to be painted. Each area should be approximately 4 square feet.

3. Prepare surface according to requirements of this specification.

4. Apply candidate coatings by proposed method of application

5. Inspect surface after approximately 1, 3, and 7 days for signs of lifting, wrinkling, cracking, or other film defects.

6. After seven days, evaluate adhesion of new coating to existing coating in accordance with ASTM D 3359.

7. If any test fails, a minimum of 3 additional locations in the section of failure shall be tested, as directed by the Engineer. If any of the retests fail, all loosely adhered or unadhered coating in the failed area, as determined by the Engineer, shall be removed and replaced at the Contractor's expense.

8. Adhesion tests shall be documented and submitted to Engineer in consistent format detailing location, test values, description of failure point/mode, scoring method employed, adhesive used, cure time of coating, adhesive, and other data as deemed necessary by Engineer.

3.10 CLEANUP

A. Remove all spattering, spits, and blemishes caused by work under this section.

B. Upon completion, remove from the premises all surplus paint materials, abrasive blast materials, equipment, rubbish, and debris resulting from work under this sections.

C. Remove spent abrasive blast material in accordance with Section 01 35 24 – Project Safety Requirements, regarding potential hazardous conditions and hazardous substances.

D. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

E. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

F. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

[See Paint System Data Sheet (PSDP) form following this Section.]

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coatings Supplier:		
Representative:		
Surface Preparation:		
Color Code:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats Coverage

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SECTION 21 13 00

DRY PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and other technical specifications and design documents, apply to the work of this Section.

1.2 SUMMARY

A. Furnish all labor, materials, and equipment for a fully operational fire alarm and emergency notification system in full compliance with the applicable NFPA standards and all other codes, regulations and laws applicable to the work, and in full compliance with the intent of the plans and specifications, including all work inferable from same.

B. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Acceptance Testing and Commissioning.

C. References

1. National Fire Protection Association (NFPA)

    a. NFPA 13, “Standard for the Installation of Sprinkler Systems”

2. Underwriter’s Laboratories, Inc. (UL)

3. International Code Council (ICC)

    a. California Building Code (CBC)

    b. California Fire Code (CFC)

4. Amendments and Requirements of the Authority or Authorities Having Jurisdiction.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Dry pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

B. Standard-Pressure Sprinklers: Sprinklers listed for a maximum system pressure of 175 psig.

C. AHJ: Authority Having Jurisdiction.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Annotated to indicate rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For dry pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.

C. Hydraulic Calculations: For dry pipe sprinkler systems.

D. Seismic Bracing Calculations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1. The Contractor for the fire alarm installation shall be a qualified Fire Protection Contractor, regularly engaged in the installation of fire protection systems with a California (C-16) Contractor License.

B. Approved Sprinkler Shop Drawings: Working plans, prepared according to NFPA 13 that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Welding certificates.

D. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dry pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

B. As-Built drawings.

C. Furnish a copy of the latest edition of NFPA 25 “Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.”

D. After completing the sprinkler system installation, the Contractor shall submit to the authority having jurisdiction a written certification that the system has been installed in accordance with the approved plans and tested in accordance with NFPA 13 and manufacturer’s recommendations.

1.7 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Contractor’s responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified contractor.
b. An experienced installer who has designed, installed, and obtained approvals for fire-suppression sprinkler systems similar to that indicated for this Project. The contractor must have a California Fire Protection (C-16) Contractor license.
c. Prior to commencing work, submit data showing that the Contractor has successfully installed fire extinguishing sprinkler systems of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having the required experience.
d. Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Codes and NFPA Standards: Dry pipe sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13, local building codes and the requirements of all Authorities Having Jurisdiction.

E. All materials and equipment shall be UL listed.

1.9 DELIVERY, STORAGE AND HANDLING

A. Store products in shipping containers until installation. Provide and maintain temporary inlet and outlet caps until installation.

B. Glass bulb sprinklers shall be shipped and stored with protective bulb shields. Bulb shields shall be removed after installation and before placing the system in service.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

A. Dry-Pipe Sprinkler System: A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers.

2.2 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Fire protection contractor shall arrange and conduct a water flow test in the presence of the local authorities having jurisdiction prior to preparation of hydraulic calculations. If a previous water flow test result is used, the test must be within 12 months prior to shop drawing submittal. Submit a copy of the test results to the Architect/Engineer for review/record.

C. Margin of Safety between Available Water Flow and Pressure and Total Calculated Sprinkler and Hose Stream: 10% including losses through water service piping, valves, and backflow preventers.

D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Sprinkler system piping shall be hydraulically calculated based on the design criteria and hazard classifications indicated on the drawings.

E. Pipe, fittings, valves, specialty valves and sprinklers shall be rated and listed for the maximum system working pressure. The use of pressure reducing or regulating valves shall not be permissible unless noted otherwise.

2.3 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

B. Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.

C. Uncoated, Cast-Iron, Malleable-Iron and Ductile-Iron Threaded Fittings: ASME B16.4, Class 125 and 150, standard pattern.

D. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125 and Class 250.

E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 and Class 300.

F. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175 psig minimum.
2. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile iron pipe and fittings shall be bituminous coated outside per ANSI 21.1 and cement mortar lined inside with seal coat in accordance with American National Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water, ANSI/AWWA C104/A21.4

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end. Minimum class 350.

C. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and Stainless Steel bolts.

D. Flanges: ASME B16.1, Class 125, cast iron.

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: Linear low-density PE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.

C. Form: Tube.

D. Color: Black.

2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.8 SPECIALTY VALVES

A. General Requirements:

1. Pressure Rating:

a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.

2. Body Material: Cast or ductile iron.
3. Size: Same as connected piping.
4. End Connections: Flanged or grooved.

B. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

C. Dry Pipe Valve

1. Standard: UL 260.
2. Pressure Rating: 175-psig minimum.
3. Size: NPS 6.
4. End Connections: Grooved.

2.9 SPRINKLER PIPING SPECIALTIES

A. General Requirements for System Fittings: UL listed.

B. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Galvanized or painted ductile-iron housing with branch outlets. Bolted split case body wrapping completely around the pipe. Saddle type fittings utilizing a single strap, snap-on, and strapless type fittings are not acceptable.
6. Size: Dimensions to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved or threaded.
8. Mechanical tee outlets shall be used for connection of new pipe to existing pipe only or in limited isolated cases for field coordination.

C. Flow Detection and Test Assemblies:

1. Pressure Rating: 175-psig minimum.
2. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
3. Size: Same as connected piping.
4. Inlet and Outlet: Threaded or grooved.

D. Sprinkler Inspector's Test Fittings:

1. Pressure Rating: 175-psig minimum.
2. Body Material: Cast- or ductile-iron housing with sight glass.
3. Size: Same as connected piping.
4. Inlet and Outlet: Threaded.

E. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory".

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.

D. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Standards: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Two single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

D. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.

3. Components: Two single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.12 SYSTEM PRESSURE RELIEF VALVE

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

2.13 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig minimum.

D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Verify underground piping has been flushed prior to connection to building fire protection piping.

B. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. Obtain final written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
3. Piping shall be installed with a minimum number of joints and couplings, but with adequate and accessible connections for disassembly, maintenance ,and replacement of piping components. Pipe shall be reamed and deburred to remove any rough edges from the end of pipe. Piping joints and connections shall be assembled airtight and watertight.

4. All piping, auxiliary drain valves that do not require regular access, and devices shall be installed as high as possible, and shall not obstruct any portion of a window, doorway, stairway, walkway, or passageway, and shall not interfere with the operation or accessibility of any existing mechanical, plumbing or electrical equipment to the Owner's satisfaction.

B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

C. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.

1. Terminate fire-suppression water-service piping within the building at the floor slab until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.

D. Piping Standard: Comply with NFPA 13 requirements.

E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install relief valve not less than ½ inch in size and set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater.

I. Provide vent at top of drain risers.

J. Provide automatic air venting valve at top of the system for exhausting air from the system.

K. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

L. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to spill in open hub drain or to outside building.

M. Install alarm devices in piping systems.

N. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA.

O. Mechanical-tee and -cross fittings may be used only for connections to existing piping for field coordination of sprinklers under ductwork and similar situations. Mechanical-tee and -cross fittings shall not be used for take-offs for typical branchlines, sprinkler drops, sprigs, etc.

P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.

Q. Fill sprinkler system piping with water.

R. The Contractor shall provide Owner approved, adequate permanent protection for any installed piping, valves, devices, or accessories which, in the Owner's opinion, are subject to physical damage.

S. When welding is performed, piping shall be shop welded. Torch cutting and welding shall not be permitted as a means of modifying or repairing standpipe systems. Welding methods shall conform to the applicable requirements of AWS B2. Welding shall not be acceptable on galvanized pipe.

T. Penetrations of ductwork shall not be permissible.

U. Torch cutting and welding shall not be permitted as a means of modifying or repairing the existing sprinkler systems.

V. Pooling of cutting oil or other petroleum-based products in the sprinklers must be avoided. Therefore, always cut and thread pipe without the sprinkler being attached and always be sure to check and drain the drops of any excessive oil prior to the installation of sprinklers.

W. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

X. Where corrosive conditions exist or piping is exposed to the weather, corrosion resistant pipe, fittings, and hangers shall be used.

Y. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

Z. No fire protection piping shall be installed inside of electrical equipment rooms except for sprinkler branch line piping serving sprinklers within the same electrical room, and all such branch line piping shall dead end within the electrical equipment room. Avoid routing sprinkler system piping and installing sprinkler heads directly over electrical equipment. Reroute piping and add additional sprinklers as required to avoid sprinklers and pipe installed directly over electrical equipment.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Threaded Joints: 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 appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

G. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

I. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

J. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

K. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.

L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

M. Rubber gasketed pipe fittings and couplings shall not be installed where ambient temperatures can be expected to exceed 150 degrees Fahrenheit (65.6 degrees Celsius), unless listed for this service.

N. A one-piece reducing fitting shall be used wherever a change is made in the size of pipe.

O. Do not use couplings to provide support point for vertical piping.

P. All grooved mechanical couplings, fittings and gaskets shall be of the same manufacturer.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install valve supervisory switches (tamper switches) on all valves controlling water supply to sprinkler systems including valves on incoming water service upstream of backflow preventer.

D. All riser room valves shall be accessible from the floor without use of a ladder.

E. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

F. Control valves installed overhead, shall be positioned so that the indicating feature is visible from the floor. Wafer type valves with components that extend beyond the valves body shall be installed in a manner that does not interfere with the operation of any system component.

G. Provide drain valves at main shutoff valves, low points of piping and trapped portions of piping per NFPA 13.

3.5 SPRINKLER INSTALLATION

A. Unless otherwise indicated, all sprinklers shall be arranged symmetrically within each room or space. All sprinklers to be installed in suspended ceilings of any type shall be aligned and shall be located as indicated on the architectural reflected ceiling plans or fire

protection plans. In areas without a suspended ceiling, install sprinkler piping as high as possible. Sprinklers shall be installed in accordance with their listing.

B. The sprinkler deflector distance for recessed pendent or flush pendent sprinklers below the suspended ceiling shall be consistent. Final sprinkler installation shall follow installation of finished ceiling. Coordination with and approval from General Contractor shall be required prior to proceeding.

C. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, soffits, ceiling and elevation changes and partition assemblies.

D. Coordinate layout and installation of sprinklers in exposed construction areas with structural elements and work of other trades.

E. Placement of sprinklers in all areas/spaces shall comply with NFPA 13.

F. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

G. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

H. Sprinklers shall be installed under fixed obstructions over 4 feet in width such as ducts, decks, open grate flooring, cutting tables and overhead doors. Sprinklers installed below 7 feet above finished floor shall be provided with head guards.

I. Sprinklers installed under open grating shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

J. Positioning of sprinkler deflector under ceiling, metal deck or slab shall conform to the requirements of NFPA 13. Deflector of sprinklers shall be aligned parallel to ceiling or roof.

K. Protective caps and straps shall be removed from all sprinklers prior to the time when the sprinkler system is placed in service.

L. A minimum of 18-inch clearance shall be maintained between top of storage and ceiling sprinkler deflector.

M. Sidewall sprinklers shall only be installed in light hazard occupancies with smooth, horizontal, or sloped, flat ceilings. Sidewall sprinklers, in ordinary hazard occupancies with smooth, flat ceilings where specifically listed for such use.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.7 FIELD QUALITY CONTROL

A. Preparation:

1. Pre-test all systems prior to performing Acceptance Testing.

    a. Pre-testing shall include performing all Acceptance Testing Activities.

2. After successful completion of pre-test activities, perform Acceptance Testing.

    a. Notify the Owner, the Owner's representative, and the Commissioning Authority of the date and time of Acceptance Testing at least seven days prior to performing Acceptance Testing.

3. After successful completion of Acceptance Testing, perform AHJ Acceptance Testing.

    a. Schedule AHJ Acceptance Testing as required by the AHJ. Coordinate schedule with Owner.

B. Equipment:

1. Provide equipment and materials as required to perform system Acceptance Testing.
2. Test instrument calibration

C. Complete system Acceptance Testing in accordance with NFPA 13 and this Section.

1. Coordinate with fire alarm tests. Operate as required.
2. Perform the following system Acceptance Testing:

    a. Visual inspection:
        1) Sprinkler systems are complete and installed in accordance with NFPA 13.
        2) Installation of equipment, valves, piping, sprinklers, hangers and supports, and seismic or sway bracing is in conformance with approved shop drawings.
        3) Locations of sprinkler with respect to obstructions are in accordance with NFPA 13.
        4) Finish work is complete.
        5) Labels and signs have been installed, are complete and correct, and match approved shop drawings.
        6) All electrical and fire alarm connections have been made.

    b. Hydrostatic testing:
        1) Prior to the hydrostatic test, test sprinkler system piping pneumatically in accordance with NFPA 13 at 40 psi for 24 hours. Any leakage that results in a loss of pressure in excess of 1½ psi for the 24 hours shall be corrected.

2) Test sprinkler system piping hydrostatically in accordance NFPA 13 at not less than 200 psi pressure for two (2) hours. When the system working pressure is in excess of 150 psi the piping shall be tested at a pressure of 50 psi in excess of system working pressure for two (2) hours. The test pressure shall be read from a gauge located at the low elevation point of the system being tested.
3) No pressure loss shall be measured during the duration of the test.
4) There shall be no visible leakage when the systems are subjected to the hydrostatic pressure test.

c. Water flow switches:
1) Test each waterflow switch, including the associated alarm circuits, by actual water flow through an inspector's test connection.
2) Participate in fire alarm system Acceptance Testing to verify proper operation of waterflow switches. Adjust or replace waterflow switches as necessary until the fire alarm system Acceptance Test criteria is satisfied.

d. Main drain test:
1) Record the static pressure.
2) Open the main drain valve. After the system pressure stabilizes record the residual pressure.
3) Record the static and residual pressure on the Acceptance Testing checklists, on the Contractor's Material and Test Certificate, and on the General Information Sign for each system.

e. Control valves:
1) Fully open and close each control valve under system water pressure to verify proper operation of valve and valve supervisory switch.
2) Participate in fire alarm system Acceptance Testing to verify proper operation of valve supervisory switches and signaling to the fire alarm system. Adjust or replace valve supervisory switches as necessary until the fire alarm system Acceptance Test criteria is satisfied.

3. Systems that do not pass tests and inspections will be considered defective.

a. Repair system and repeat test or inspection until all defects have been corrected.

4. Prepare test and inspection reports and submit to the Authority Having Jurisdiction. Include the following:

a. NFPA 13 Contractor's Material and Test Certificate for Aboveground Piping for each sprinkler system

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

C. Remove tape and other temporary coverings used to protect sprinklers.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

B. Above ground piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

C. Standard-pressure, dry pipe sprinkler system piping shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright or pendent sprinklers.
2. Rooms with Suspended Ceilings: Semi-recessed sprinklers, unless noted otherwise.
3. Wall or Soffit Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Recessed Sprinklers: chrome escutcheon and sprinkler.
2. Upright and Pendent Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, chlorine, ammonia or other corrosive fumes.
3. Sidewall Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, chlorine, ammonia or other corrosive fumes.

C. Two-piece escutcheon plates on pendent or sidewall sprinklers are not allowed, unless noted otherwise.

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SECTION 22 05 00

AIR COMPRESSOR MOTOR REPLACEMENT

PART 1 – GENERAL

1.1 SUMMARY

A. BACKGROUND: The District's Main Wastewater Treatment Plant Oxygen Production Facility includes four (4) Main Air Compressors (MAC) originally manufactured by Joy Manufacturing in the 1970's. The compressor manufacturer is now owned by Ingersoll Rand. Three of the four MAC's have recently been modified to increase their capacity from 5850 ICFM (Inlet Cubic Feet per Minute) to 7020 ICFM, and one MAC will be modified over the duration of the Contract by others. This increase led to operation of the existing MAC 1250 HP motors well into their service factor. The existing 1250 HP motors will be replaced with new 1500 HP motors for improved reliability as well as increased compressor capacity.

B. The Contractor shall replace the existing 1250 HP motors with 1500 HP motors for all four MACs. The work includes field verification, testing, and start-up/commissioning.

1. The Contractor shall sequence and coordinate this work with other Work in the Drawings and Specifications.

C. The 1500 HP motors and half-coupling parts are purchased by and are furnished by the District. The Installation Contractor is to install these motors per the manufacturer's recommendations and per the requirements of the Drawings and Specifications.

2. The installation and testing (alignment, balance, vibration) of the 1500 HP motors shall be performed by the Contractor's Installation Contractor with support from the District's MAC Motor supplier.

3. The motor is connected to the compressor through a stub shaft (inching drive) with coupling hubs on each end. The District will provide the Contractor four sets of couplings for each MAC (total 16 half couplings for four MACs). The Contractor shall install the couplings and be responsible for installation and alignment in accordance with Manufacturer's Installation requirements.

D. NOT USED.

E. The Installation Contractor is required to install the new motors in the existing location. The location of the new motors will require coordination with the District to avoid disruption to plant operations. Use of the District's existing overhead hoist and cranes should be verified before replacement of the motors.

1. The source for the overhead crane is MCC P16.

F. The existing reduced voltage autotransformer type motor starters shall be used with the new motors. The tap settings shall be adjusted as required by the Contractor to allow the appropriate inrush current for starting purposes.

G. New separately mounted termination boxes as shown on the Drawings shall be provided by the Contractor. The termination boxes shall house the new arrestors, surge capacitors and neutral CTs. The location of the new termination box shall be aligned with the existing conduits and motor cable entry.

H. The Installation Contractor shall furnish the necessary labor, materials, instruments, transportation, and devices required to store, handle, test, adjust and balance the air compressor systems. Each system as specified and detailed, shall perform in accordance with the intent of the Drawings and this Section. Systems to be tested, adjusted, and balanced include the existing air compressor.

I. The Installation Contractor shall test the motors before the MACs are returned to service. Testing of the motors shall include vibration testing and shaft alignment for balancing as required in PART 3. These tests shall be coordinated with the functional testing requirements of the air compressor system and as required in Section 01 75 17, Field Testing and Startup. Testing shall be performed by the Contractor's qualified and experienced personnel, having formerly done similar Work and whose qualifications and performance shall be subject to the approval of the Engineer.

J. Provide labor, tools, equipment, and materials necessary to furnish and install electrical work as specified and in accordance with the Drawings and applicable reference standards listed in Article 1.3.

K. The Installation Contractor shall coordinate with the District to obtain and retrieve the motor for installation.

L. The motor manufacturer's supplier Koffler Electrical Mechanical Apparatus Repair, Inc. in San Leandro California will be providing the motor testing services and certification. The Installation Contractor shall coordinate with the manufacturer's supplier regarding scheduling of testing the motors. The Installation Contractor shall be available and provide the necessary labor and materials for these tests done by the motor manufacturer's supplier. Testing of the MACs shall be completed prior to start-up of the cold boxes (on each side of the oxygen plant being worked on).

1. Testing provided by motor manufacturer's supplier:

   a. Sound level (maximum) shall be 85 dBA at 3 feet, at no-load

   b. Locked (starting) rotor current shall be 6.3 or less x FLA

   c. The motor shall accelerate the compressor to full speed within 25 seconds or less.

   d. The maximum temperature rise shall be 80 degree C at 1.0 SF and 90 degrees C at 1.15 SF maximum as measured by the RTD method.

e. Vibrations shall not exceed 0.10 in/sec peak uncoupled or coupled. Vibrations shall be measured during full load testing.

M. The Installation Contractor is required to attend a preconstruction meeting for the MAC work.

N. The Installation Contractor shall remove the fuel oil pump (external gear pump) connected to the non-drive end of the existing motor and reinstall it as indicated on the mechanical drawings.

1.2 SUBMITTALS

A. Submit welders' certificates specified in Quality Assurance below.

B. Submit MAC motor surge protector product literature and O&M manual. Provide product literature for surge arrestors.

C. Submit sample "blank" alignment report for review by the Engineer prior to motor installation. Alignment report shall include pre-startup inspection procedures, testing procedures, shim specifications, half shaft coupling data sheets and alignment check procedure, and other details of the motor installation.

D. Submit completed alignment report after all the shimming and motor adjustments have been completed. Alignment reports shall be submitted prior to startup of motors.

E. Submit motor vibration test results.

F. Submit method of handling motor installation and provide sketch to confirm clearance requirements for motor installation.

1.3 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications http://www.asme.org/.

B. Welding procedures and testing shall comply with ANSI Standard B31.1.0 Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook http://www.ansi.org/.

C. Soldering and brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration http://www.ansi.org/.

D. Sustainable Design Requirements

1. Local/Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of Project site.

2. Low-Emitting Materials, Adhesives and Sealants: Furnish materials that comply with the requirements of South Coast Air Quality Management District (SCAQMD), Ruling #168, July 1, 2005.

E. Submit Installation Contractor's qualifications.

1. Installation Contractor shall be regularly engaged in the business of installing medium voltage induction motors for air compressors. Installation Contractor personnel performing the Work shall have at least 5 of experience installing medium voltage induction motors and have worked on at least one project of a similar size.

F. Submit Manufacturer's supplier certificate of proper installation and certificate of motor testing for each MAC motor in accordance with 01 75 17, Field Testing and Startup.

G. Submit qualifications of personnel who will perform testing on the motors.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

D. Store in a clean, dry, well-ventilated place, free from vibration and rapid or wide variations in temperature. Rotate the shaft a minimum of 10 complete turns by hand each month to coat the bearings with lubricant which will prevent oxidation or corrosion. If drain plugs are provided in enclosed motors, they must be removed periodically to drain any water accumulation from the motor. Contractor shall use space heater to maintain environmental conditions in accordance with Manufacturer's Instruction Manual.

E. The Installation Contractor is required to avoid existing conduits and piping during the motor installation and provide equipment necessary to clear existing equipment.

1.5 SITE VISIT REQUIREMENT

A. The District furnished motor will be coupled to an existing skid mounted air compressor. The Installation Contractor is required to coordinate a site visit with the District to fully investigate each air compressor system how the motor will be handled during installation, how the motor will be shimmed and how the MAC motor will be coupled to the existing air compressor system.

B. For MACs that need to be shutdown for safe investigation purposes the Contractor shall provide at least two weeks notice to the District and submit a System Outage Request (SOR) in accordance with Section 01 35 13, Special Project Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL

A. All mechanical equipment and materials proposed for this project shall be new and purchased specifically for this project.

B. Damaged, dented, bent, scarred, or scratched equipment or materials shall be not installed.

C. When damage has occurred, the Contractor shall notify the District's authorized representative, within 24 hours of the damage, for review and resolution of the damage problem.

2.2 VIBRATION REQUIREMENTS

A. Mounting feet or surfaces of rotating equipment shall be machined.

B. Base Structure: Cast iron or welded steel construction with ribs or bracing to prevent distortion and machine surfaces where equipment is to be mounted. Tolerance shall be +/-0.002 inches between mounting pads. Base structure shall have mounting holes around perimeter. Center distance between these holes shall not be more than 30 inches.

C. Hollow Bases: Holes sufficiently large in top of base for filling and venting grout, throughout the entire base. If cross-members are provided in the base, provide grout vent holes for each base segment.

D. Dynamic balancing and unbalance vibration of the rotating element (or rotor) shall be as follows:

1. Motor rotors shall be balanced in accordance with NEMA MG-1 standards to a Special Balance tolerance to give an amplitude of vibration of no more than 0.8 mils on the bearing housings. If the motor manufacturers tolerances are more stringent, then they shall apply.

E. Shaft Alignment Requirements: On coupled rotating equipment installation where driver and driven units are supplied as a factory mounted unit, shafts shall be aligned in angular and offset positions and within tolerances as specified in this section with all hold-down bolts/nuts tight.

2.3 MOTOR SURGE PROTECTION EQUIPMENT

A. Provide a medium voltage, three phase motor surge protector that is designed to protect medium voltage motors from voltage surges due to lightning and switching events. The motor surge protector will be installed on a 4160V system (line-line

voltage) which is ungrounded. The surge protector shall be NEPSI (Northeast Power Systems, Inc.) part number MSP6A0416 or Equal.

B. Enclosure

2. The surge protector shall be housed in a NEMA 12, 11 gauge, all-welded, steel enclosure. The enclosure shall be equipped with a hinged door which shall bolt closed with two 3/8" x 16 stainless steel bolts. The hinges shall be stainless steel and the door shall be removable when in the open position.

3. High voltage warning signs and a nameplate showing rating information shall be located on the front of the enclosure.

C. Surge Capacitors

1. A low inductance, three phase, all-film surge capacitor shall be provided for decreasing the slope of impending voltage surges. The capacitor shall be rated 0.5 micro-farads.

2. The surge capacitor shall be equipped with discharge resistors that reduce the capacitor voltage to 50V in 5 minutes when disconnected from the source.

3. The surge capacitor shall be capable of operating between -40 degrees F and 115 degrees F.

D. Surge Arrester

1. The surge protector shall be equipped with three heavy duty distribution class surge arresters for limiting the crest of impending voltage surges to safe values.

2. The surge arresters shall be silicone rubber housed and shall utilize MOV blocks. The arresters shall comply with ANSI C62.11 standards.

2.4 NEUTRAL CURRENT TRANSFORMER ENCLOSURE

A. Enclosure

1. Current transformer enclosure shall be NEMA 12, ANSI 61 gray.

2. Material shall be minimum 14 gauge mild steel.

3. Enclosure shall measure 36" high, 36" wide, 24" deep.

4. Enclosure shall be equipped with a single hinged door which is either lockable or is bolted closed.

5. A backpanel compatible with enclosure shall be provided for mounting components.

B. Neutral Current Transformers

1. Provide three bar-type current transformers and install in the CT enclosure in accordance with drawing number SD428-W4400-E901.

2. CTs shall be GE Grid Solutions model JKM-3C or Equal.

3. CTs shall be single ratio, 300:5.

4. CTs shall be rated 5KV, 60KV BIL.

C. Neutral Bus Bar

1. Provide copper neutral bus bar measuring 24" long, 1" wide, ¼" thick and install in the CT enclosure in accordance with drawing number SD428-W400-E901 or Approved Equal.

D. Insulators

1. Provide two neutral bus bar insulators and install according to drawing number SD428-W4400-E901.

2. Insulators shall be NVENT ERIFLEX, ERICO part number 559694, or Equal.

3. Insulators shall be 3" high, 2.5" wide.

2.5 DESIGN VIBRATION REQUIREMENTS

E. The machine base of the rotating equipment shall be mounted on the sub-base in a manner that is level in both directions according to the machined surfaces on the base. If sub-base is cast-in-place concrete, coordinate drawings to show details of steel reinforcement. The base is to be supported firmly by hold-down bolts all the way around the base and grouted when necessary.

F. Motor Bearing Vibration Sensors and Transmitters

1. The District will provide two Wilcoxon triaxial accelerometers 993A to the Contractor for each MAC motor. The Contractor shall install one accelerometer on each bearing end (or one on the drive end, one on the non-drive end). The accelerometer on the drive end shall be configured to measure vibration in the x, y, and z-axis. The accelerometer on the non-drive end shall be configured to measure vibration in the x and y-axis.

   a. The District will provide eight accelerometers total. The Contractor shall coordinate handoff for the accelerometers.

   b. The motors have taps for 1/4-28 connections on the bearing assembly enclosure. The Contractor shall modify the bearing enclosure as needed to fit up the accelerometers.

2. The Contractor shall provide 22 Wilcoxon iT301 vibration transmitters. These transmitters shall be mounted in their respective MAC RIO cabinets. One transmitter is needed for each axis. Two transmitters will be provided as spares to be handed off to the District.

2.6 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded http://www.asme.org/.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined http://www.asme.org/.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system. Lead bearing solders shall not be used.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21) http://www.ansi.org/. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

PART 3 - EXECUTION

3.1 PREPARATION

A. Select a location for the MAC motor that will:

1. Be clean, dry, well ventilated, properly drained, and provide accessibility for inspection, lubrication, and maintenance.

2. Provide adequate space for future motor removal without shifting the driven unit.

3. Permit the motor to safely deliver adequate power. Temperature rise of a standard motor is based on operation at an altitude not higher than 3,300 feet above sea level.

4. Avoid condensation of moisture in bearings and on windings. Motors shall not be stored in areas subject to rapid temperature changes unless motors are energized or protected with space heaters.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the systems.

3.2 INSTALLATION

A. Handling

1. The Installation Contractor shall receive, uncrate, set in place, level and install the equipment according to the installation drawings, Manufacturer's Instructions, and in coordination with the District.

2. Lifting devices are provided for handling only. An experienced rigger should be used to install motors.

3. To avoid damage, the use of spreader bars is recommended on other than single point lifts. Lifting devices are typically provided to facilitate handling with shackles and cables.

4. Avoid pounding or bumping shaft, coupling, or bearing parts, as shocks may damage bearings.

5. Note weight of motor before lifting. Apply tension gradually to cables. Do not jerk or attempt to move the unit suddenly.

B. Mounting

1. Mount the motor base on existing flange foundation.

   a. Sub-base that supports the equipment base and made of concrete shall be reinforced with steel reinforcements of the proper design as indicated.

   b. The sub-base shall be level in both directions. Particular care shall be taken at hold-down bolt locations so that these areas are flat and level.

   c. Machine bases of rotation equipment shall be mounted on sub-bases in a manner that they are level in both directions according to machined surfaces on base.

   d. Leveling of machine bases on sub-bases and alignment of shafts between driver and driven unit shall be accomplished by use of stainless steel blocks and stainless steel precision cut and shims.

   e. Blocks and shims shall be generously sized to provide solid support at each anchor bolt location.

   f. Provide blocks and shims at each anchor bolt. Blocks and shims shall be square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.

      1) Verify bolt hole location and depth for new motors. Perform any modifications of the foundation to mount the motors with manufacturer's approval in writing.

2. Shim as required to level. Use laser or spirit level (check two directions at 90°) to ensure motor feet will be in one plane (base not warped) when base bolts are tightened.

3. Set motor on the base, install nuts, and tighten. Do not tighten until after alignment.

C. Coupling of Sleeve Bearing Motors

1. Sleeve bearings cannot withstand externally generated axial thrust. Antifriction bearings are normally designed to handle a minimum thrust. As the motor and driven equipment get hot they may expand towards each other and with the wrong coupling. If properly installed, the following types of couplings are considered to be free from the development of axial thrust and may be used.

a. Laminated Metal Disk Type

b. Rubber Biscuit Type

c. Pin and Bushing Type

d. Gear Type

D. External Wiring

1. Starting and overload control devices must be matched to the motor rating. For safety or convenience the may need to be installed some distance from the motor. Follow the motor manufactures instructions to make proper installations and connections.

2. Connect electrical power supply to conform with National Electric Code and any local regulations. Line voltage and wire capacity must match motor rating stamped on the nameplate.

3. With the driven equipment disconnected, momentarily energize the motor to check rotation.

E. Alignment

1. Accurate shaft alignment between motor and driven equipment is essential. Improper alignment may result in vibration, bearing overloads and excessive shaft stresses. Flexible couplings will not compensate for excessive misalignment.

2. Machinery Shaft Alignment: All rotating motor-driven equipment shafts with couplings shall be aligned as installed on-site using a computer-aided optical laser. The transducer system (where applicable), which houses the Class 1 laser diode and a position detector, and the prism shall be installed on the respective shafts, then adjusted such that the laser beam is reflected back into the position detector. As the shafts are rotated through 180 degrees, any parallel offset or angularity shall deflect the reflected beam from its original point of incidence in the position detector. The position detector measurements shall automatically enter the computer, which shall calculate misalignment from the beam deflection, and then display shaft

misalignment at the coupling and corrective measures to the nearest 0.0005 inches at the machine feet.

a. Preliminary and final alignments shall be performed. Preliminary alignment shall occur before grouting of the base, connection the piping and cabling connections are performed. During preliminary alignment, soft foot function shall measure machine feet sitting unevenly on the foundation and determine the necessary corrections. Measurement of the amounts and directions of misalignment, calculations of corrective moves, and initial alignment shall be performed.

b. Following the completion of all connections and grouting, the final alignment shall be performed.

c. The computer shall automatically calculate alignment specifications into the corrections such that when thermal growth is present, the machines will be positioned to grow into optimum alignment at operating temperatures. All data collected will be permanently recorded in a report and included in the final O&M manual for the equipment.

d. Shims used to adjust alignment shall be factory precut stainless steel sized for the appropriate motor horsepower.

e. Accuracy of the optical laser alignment system shall be traceable to the National Institute of Standards and Technology. Allowable equipment tolerances are as set forth elsewhere in this Section.

f. Coupling manufacturer alignment tolerances shall not be used for shaft alignment tolerances. The tolerances specified herein shall apply to both vertical and horizontal alignments measured at or calculated to the coupling centerline. In cases where the equipment manufacturer requires more stringent shaft alignment standards, the manufacturer's standards shall apply.

g. If the equipment comes as a factory mounted/aligned unit the shaft alignment shall be rechecked as installed on site and any misalignment corrected in accordance with these specifications and tolerance herein.

3. Brief Explanation Of Terms

a. Machine To Be Shimmed ("M.T.B.S."): When two machines must be aligned to each other, any necessary adjustments will usually be done on only one of the machines. Usually, the driver will be the machine that must be adjusted. The term “Machine to be shimmed” shall be used to describe the machine that is to be shimmed.

b. Stationary Machine: The term “Stationary Machine” shall be used to describe the machine that is usually not adjusted (the pump, fan, gear reducer, air compressor, etc. in most cases).

c. Horizontal Misalignment: When the "M.T.B.S." must be adjusted horizontally to bring it into its correct position. (Shims are not used to correct horizontal misalignment.) This term applies to horizontally mounted machines.

d. Angularity: The angle that one shaft centerline makes in relation to the other shaft centerline. For clarity, this is expressed as a "slope" of so many thousandths of an inch PER inch, rather than as an angle of so many degrees. This must be determined in both the vertical and horizontal planes (vertical angularity and horizontal angularity) on horizontally mounted machines and east-west and north-south planes on vertically coupled shafts.

e. Offset: The distance (in thousandths of an inch) between two shaft centerlines. For purposes of standardization, this distance will always be calculated to (or measured at) the centerline of the coupling. This must be determined in both the vertical and horizontal planes (vertical offset and horizontal offset) on horizontally mounted machines and east-west and north- south planes on vertical coupled shafts.

f. Soft Foot: A condition that exists when the bottom of all four feet of the moveable machines are not machined on the same plane or resting on the same plane (can be compared to a chair that has one short leg).

g. Jacking Bolts: Horizontally positioned bolts on the machine base that are located at each foot of the machine and are used to adjust the horizontal position of the machine. Jacking bolts are not used to hold the machine in place.

4. Prior to final shaft alignment, the following criteria must be met:

a. Machinery foundation must be installed as designed with the base parallel with respect to the machine's shaft on horizontally mounted machines.

b. Machinery must be free of piping strain. To check for piping strain, piping flanges should be loosened up separately with flange movement observed continuously. Should movement exceed 1/8-inch, piping strain is considered excessive and shall be corrected by adding or adjusting pipe supports, hangers, expansion joints, etc.

c. Machinery must be resting firmly on the mounting bases with equal loading on each support.

d. Horizontally mounted machinery (coupled) over 125 horsepower shall be provided with fine-thread jackbolts for horizontal alignment adjustments. Machine foothold down bolts shall be loosened before horizontal position adjustments are made with the jackbolts.

e. Machinery supports and baseplate pads shall be free of burrs, rust, scale, and other obstructions.

f. Stainless steel pre-cut shims shall be used to provide a firm, solid, adjustable link between machine and baseplate.

g. Machinery must be free of soft foot. To check for soft foot, the machinery must be firmly bolted to the baseplate. Each support foot is checked with the dial indicator and/or feeler gauges, loosening hold-down bolts one at a time. If movement exceeds 0.002 inches, soft foot is indicated. Shim and torque uniformly to minimize soft foot. (see Drawing 4 in Appendix A.)

h. All jackbolts shall be backed-off (1) turn after the alignment procedure is complete.

i. All final alignment data for each machine assembly shall be recorded by the contractor on the Machinery Alignment Report, one electronic PDF copy and three (3) copies of which will be submitted to the project manager for distribution.

F. Parallel Alignment

1. After positioning unit for correct end float, separate the coupling halves and mount a dial indicator rigidly on one coupling half with the button on the cylindrical surface of the other half.

2. Rotate the shafts together, and take readings at top, bottom, and side positions.

3. Align shaft so that the difference between top and bottom readings and the side readings is a maximum of 0.002 inches for a flexible coupling.

G. Angular Alignment

1. Hold each shaft at maximum end float. Rotate both shafts together and measure between matching points at the outside diameter of the coupling faces for the top, bottom, and both sides.

2. Use two indicators because of the possible axial shaft movement. Read difference of variation between them.

3. Align shafts so that the total indicator variation does not exceed 0.002 inches.

H. A basic rule is to not have more than five shims in a shim pack under any one motor foot. Thick shim packs will cause soft foot, excessive vibration, or twisted frame (motor foot out of plane).

I. After erection, the contractor shall demonstrate that all equipment is operating in a satisfactory manner. All adjustments shall be made to suit anticipated operating conditions. Each piece of machinery shall be tested to show that it operates quietly without excessive vibration, overheating, or signs of distress at specified capacity. The engineer shall be notified in advance of all tests, and all tests shall be conducted to his entire satisfaction. All tests shall be made by the manufacturers' representative and the results recorded and submitted to the County. Vibration testing and acceptance shall be done in accordance with the Performance Testing in Appendix B, E, and F of these design standards.

J. Manufacturer's certificates that the installation of the equipment is in accordance with the manufacturer's recommendations shall be secured by the contractor and submitted to the engineer.

K. Certification that the equipment shafts are aligned to the alignment tolerances specified.

L. Certification that equipment rotors have been dynamically balanced within the tolerances specified.

M. Foot Plane

1. The proper foot plane exists when adequate shims have been installed to assure equal pressure on each foot or corner of motor when the mounting bolts are loose.

2. Mount dial indicator on shaft to be checked so that contact will rest on either the adjacent shaft or a bracket from the foundation or base.

3. With mounting bolts tight and indicator set at zero, release one bolt at the shaft extension end of the unit and check the indicator for a maximum change of 0.001 inches.

4. If no change is indicated, re-tighten the bolt, and repeat the process for each of the remaining bolts.

5. If a change is indicated, add shims under motor foot and re-tighten until indicator movement is reduced or eliminated.

N. Vibration

1. The standard unfiltered housing vibration limits measured at no load, uncoupled, and with rigid mounting are as follows based on the requirements of NEMA MG1-7.8.

Speed	Velocity, inches/sec peak
1200 – 3600 RPM	0.120
1000 RPM	0.105
900 RPM	0.096
750 RPM	0.079
720 RPM	0.075
600 RPM	0.063

2. After alignment is complete and foot mounting bolts are tight, run motor at no load (or minimum possible). Check for vibration.

3. If excessive vibration exists and the alignment is acceptable, check foot plane by loosening one drive end mounting bolt at a time and re-check vibration until within acceptable limit.

O. Doweling

1. After controlling rotor end float and establishing accurate alignment, it is recommended to drill and ream the foundation plate and motor feet together for dowel pins. Doweling the motor (and driven unit) restricts movement, eases realignment if motor is removed from base, and temporarily restrains the motor should mounting bolts loosen.

2. Re-check parallel and angular alignment after the unit has been in operation approximately one week before bolting the coupling together. Motor shaft should be level within 0.03 inches after alignment.

3. Using pre-drilled dowel holes in motor feet as guides, drill into the mounting base.

4. Ream holes in the feet and base to the proper diameter for tapered dowel pins. Clean out the chips.

5. Insert dowel pins.

3.3 INITIAL START UP

A. Motor Checks

1. Coordinate this motor check testing with the motor manufacturer's supplier the testing requirements.

2. Check that motor, starting, and control device connections agree with wiring diagrams.

3. Check that voltage, phase, frequency of line circuit (power supply) agree with motor nameplate.

4. Check motor service record and tags accompanying motor. Ensure bearings have been properly lubricated and oil wells are filled. See motor outline drawing to determine proper oil level.

5. Remove external motor load and turn shaft by hand to ensure free rotation.

6. Run motor at no load long enough to be certain that no unusual condition exists. Listen and monitor for excessive noise, vibration, clicking or pounding and that oil rings are turning if so equipped. If present, stop motor immediately. Investigate cause and correct before putting motor in service.

7. When checks are satisfactory, operate motor at lowest load possible and look for any unusual conditions. Increase load slowly to maximum checking unit for satisfactory operation.

B. Alignment Checks

1. After completion of installation of each air compressor motor and verification of motor rotation, the motor and compressor must be aligned, initially in a cold condition to be followed by a hot alignment after the compressor has been run and allowed to reach normal operating temperatures.

2. All alignment procedures must be executed in strict accordance with the compressor and motor manufacturer specifications and must be witnessed by a District representative.

3. All mounting bolts and fixtures must be torqued to their final design values prior to recording final alignment. No further tightening or adjustments will be permitted after final alignment measurements.

4. Alignment reports documenting the As Found and As Left conditions for each alignment must be provided to and accepted by the Engineer.

C. Air Compressor System Checks

1. Once the motor check and alignment check have been completed with favorable results, the Installation Contractor shall provide a functional test of the air compressor system in accordance with the Joy Turbo-Air TA-70RR Centrifugal Compressor O&M Manual and Section 01 75 17, Field Testing and Startup.

2. Perform a cold alignment of the compressor and new motor uncoupled.

3. Perform a hot alignment in accordance with the Joy Compressor O&M Manual. Monitor vibration.

   a. Perform realignment if alignment is not within specification.

   b. Perform rebalancing of compressor if compressor vibrations are out of specification.

   c. Perform rebalancing of motor if motor vibrations are outside of specification.

END OF SECTION

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems
4. Thermal hanger-shield inserts.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.

2. Metal framing systems.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

C. Hanger Rods:

1. Description: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

2. Standard: MFMA-4.

3. Channels: Continuous slotted steel channel with inturned lips.

4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

6. Metallic Coating: Hot-dipped galvanized.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, loops, bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B 31.9 for building services piping.

K. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B 31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: 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 (DN 100): 12 inches (305 mm) long and 0.06 inch thick.

   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.4 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION

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SECTION 22 05 53.05

PIPE IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Furnish and install piping identification markers for exposed piping as specified herein.

B. Related work specified elsewhere:

1. Section 09 90 00 – Painting and Coatings

2. NOT USED

1.2 REFERENCES

A. American National Standards Institute (ANSI) Z535.1 – Safety Color Code

1.3 SUBMITTALS

A. Submit the following as specified herein and in accordance with Section 01 33 00, Submittal Procedures:

B. Descriptive literature for markers: The literature and drawings shall contain the manufacturer's name, description, manufacturers' product data, and the full item number or designation.

C. Piping marker table listing each piping service with proposed marker lettering and colors.

PART 2 - PRODUCTS

2.1 PAINTING

A. Paint as specified in Section 09 90 00, Painting and Coatings and per schedule.

B. Pipe System Color shall be as specified in the Schedule.

C. Special Items:

1. In addition, special painting of following items will be required:

ITEM	COLOR
Hoist hooks and blocks	Yellow and black stripes
Steel guard posts	ANSI Safety Yellow

2. Paint minimum legibly numbers on or adjacent to accessible valves, pumps, flow-meters, and other items of equipment which are identified on Drawings or in Specifications by number.

2.2 ADHESIVE MARKERS

A. Self-adhesive vinyl, suitable for outdoor application from –40 degrees to 180 degrees Fahrenheit.

B. Minimum thickness shall be 0.004-inch.

C. Each marker shall include:

1. Multiple axial-mounted text blocks to allow visibility from all likely viewing directions.

2. Pipe banding tape with repeating flow arrows surrounding the entire pipe circumference on both ends of the pipe marker. Arrow colors shall be the same as the lettering color.

D. Marker Colors:

1. Refer to the Standard Drawing (STD-G-005) for the marker lettering and background colors for label use.

E. Lettering:

Pipe Outer Diameter	Lettering Size
Less than 0.75 inches	Permanently legible tag
0.75 inches to 1.25 inches	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches

over 10 inches	3-1/2 inches

F. As manufactured by:

1. Seton, Opti Code Pipe Markers
2. Lab Safety Supply
3. or equal.

PART 3 - EXECUTION

3.1 PAINTING

A. Color Code:

1. Paint piping scheduled to be color coded completely with specified colors.
2. NOT USED.

3.2 ADHESIVE MARKER

A. Prepare surface in accordance with product manufacturer's instructions. Ensure surface is clean, dry, and free of dust or debris.

B. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

C. Provide piping marker letters and colors as scheduled.

D. Install adhesive markers at the following locations:

1. adjacent to equipment served and adjacent to valves
2. both sides of walls and floors where pipe passes through
3. adjacent to changes in direction (e.g., upstream and downstream of elbows, bends, tees, etc.)
4. at intervals of not more than 20 feet in straight runs of pipe

E. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere. Install two labels on opposite, or near opposite, sides of the pipe if pipe is visible from two directions (e.g., piping crossing between two work areas or walkways).

3.3 PIPING SYSTEM COLOR SCHEDULE

ID	PIPING SYSTEM	PIPE (SYSTEM) COLOR	COLOR CODE				
			Tnemec	Devoe	Carboline	PPG	S-W
5W	Fire Service	ANSI Safety Red	06SF	DC9000	7573	PC895	4081
1W	Potable Water (1W)	ANSI Safety Blue	11SF	DC9800	9112	PC865	4086
O2	Oxygen (SST)	None	--	--	--	--	--
--	MWWTP Process – All Other Interior (epoxy)	Popcorn	1029 - PA21	Match	0842	2012-1531	CCC0471-15
--	MWWTP Process – All Other Exterior (polyurethane)	Popcorn	Match	Match	Match	2012-1532	CCC0470-15
--	All PE or HDPE piping	Use solid color pipe or co-extrusion stripes based on the piping system color.	Various	Various	Various	Various	Various

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

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. Copper tube and fittings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.
5. Dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by District or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Contractor shall submit System Outage Request (SOR) for Engineer's approval for any water service that needs to be taken out of service, including potable water (1W) and fire flow (5W) services.

2. Contractor shall not interrupt water service without District's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 372 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.

3. Ball-and-socket, metal-to-metal seating surfaces.

4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Standard: ASSE 1079.

2. Pressure Rating: 150 psig.

3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Standard: ASSE 1079.

2. Factory-fabricated, bolted, companion-flange assembly.

3. Pressure Rating: 150 psig.

4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

F. Install piping to permit valve servicing.

G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

K. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Brazed Joints for Copper Tubing: Comply with CDA's Copper Tube Handbook, Brazed Joints chapter.

D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

B. Comply with requirements for seismic bracing in accordance with the latest SMACNA Guidelines for Seismic Restraints of Mechanical Systems and Piping Systems and ASCE 7-22 Minimum Design Loads for Buildings and Other Structures; the most stringent shall govern.

C. Support horizontal piping within 12 inches of each fitting and valves.

D. Support vertical runs of copper diameters to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for copper tubing with maximum horizontal spacing and minimum rod diameters to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

B. Label pressure piping with system operating pressure.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in Piping Tests Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.

   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

   b. Fill and isolate system according to either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.

      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

   d. Repeat procedures if biological examination shows contamination.

e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L cast or wrought-copper, solder-joint fittings; and brazed joints.

D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.

3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

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. Temperature-actuated, water mixing valves.
2. Strainers for domestic water piping.
3. Flexible connectors.
4. Drain valves.
5. Pressure control valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water Tempering Valves:

1. Standard: ASSE 1070, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough or chrome-plated bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Pressure Drop: 5 psi maximum at valve flow rate unless otherwise indicated.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.

2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.

3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations unless otherwise indicated.

5. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.033 inch.

   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

6. Drain: Pipe plug.

7. Pressure Drop: 3 psi maximum at valve flow rate unless otherwise indicated.

2.5 FLEXIBLE CONNECTORS

A. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.

3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for full-port, two-piece ball valves.

2. Pressure Rating: 400-psig minimum CWP.

3. Size: NPS 1.

4. Body: Copper alloy.

5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.

9. Outlet (where applicable): Threaded, short nipple with ¾ inch garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.7 PRESSURE CONTROL VALVES

A. Water Hammer Arresters:

1. Standard: ANSI/ASSE 1010 Performance Requirements For Water Hammer Arresters

2. Pressure Rating: Minimum 150-psig.

3. Size: NPS 1.

4. Body: Copper.

5. End connection: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

B. Y-Pattern Strainers: For water, install per drawings.

3.2 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

C. Comply with requirements for ground equipment in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Temperature-actuated, water mixing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53.05 - Identification for Plumbing Piping and Equipment.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Note any defects or failures.

3.5 ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. Division 26, Electrical, covers the work necessary for the complete electrical system. Furnish materials, labor, and equipment in accordance with these Specifications and the accompanying drawings.

2. Division 26, Electrical, in its entirety apply to all electrical work and equipment furnished on this project whether furnished or specified under this or other divisions of these Specifications.

3. Division 01, General Requirements, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

4. Like items of materials provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

5. All area of work under this project is outdoor. All materials to be installed shall be rated for outdoor environment Type NEMA 4X, SS316 unless noted otherwise.

6. This project includes the removal of various pneumatic instruments, gages, tubing, etc. Refer to Specification Section 40 70 00 for Instrument Index indicating specific pieces of equipment to be demolished and replaced.

7. In the main air compressor area all electrical materials installed shall be rated for outdoor environment Type NEMA 4X, SS316 unless noted otherwise.

8. Provide and install a new main air compressor motor termination box for each new motor (total of four) and support rack as indicated on the Drawings. The motor termination box shall include a lightning arrestor, surge capacitor, and power blocks. Refer to Specification Section 22 05 00 for requirements.

9. Provide and install Neutral Current Transformer enclosure for each new motor on the support rack as indicated on the Drawings. Refer to Specification Section 22 05 00 for requirements.

10. The Contractor shall remove and install four (4) District furnished main air compressor (MAC) motors. The Contractor shall provide all equipment necessary for installing the motor and provide coordination with the motor manufacturer. Field testing of the motor with the air compressor system shall be provided and coordinated with Division 22 and 40.

11. The Contractor shall change the tap settings as indicated on the Drawings for the MAC Motor Autotransformer Controllers located in the electrical room and make modifications to the existing control schematic as shown on the Drawings.

12. The Contractor shall provide demolition services as indicated on the Drawings including removal of instrumentation, control panels, wiring, cable trays and conduits.

13. The Contractor shall perform testing of all protection relays (12 total) in the S-3 switchgear.

14. The Contractor shall perform testing of all switchgear breakers for substation U10 (3 total), U11 (2 total), and U10-U11 tie breaker (1 total). Switchgear breakers are Cutler Hammer DSIL.

15. The Contractor shall perform breaker testing and thermographic survey scans on all breakers for MCC-P15 (20 total), MCC-P16 (20 total) and MCC-P17 (16 total). The MCC breakers are manufactured by GE.

16. Thermographic testing of existing and new cable connections shall be provided as indicated in this specification section.

1.2 QUALITY ASSURANCE

A. Codes and Standards

1. The components covered by these Specifications shall be designed, tested, assembled, and installed in accordance with the minimum requirements of the latest published standards of the California Electric Code (CEC), National Electrical Safety Code (NESC), Underwriters Laboratory (UL), American National Standard Institute (ANSI), Institute of Electrical and Electronic Engineers, Inc. (IEEE), National Electrical Manufacturers Association (NEMA), and the National Electrical Installation Standards (NEIS).

B. Material and Equipment Qualifications

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products, which are of equal material, design and workmanship. Products shall have been in satisfactory industrial use for 10 years prior to bid opening. The 10 year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 10 year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacture; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

C. Alternative Qualifications

1. Products having less than a 10 year field service record will be acceptable if a certified record of satisfactory field operation for not less than 20,000 hours, exclusive of the manufacturer's factory or laboratory tests, is furnished.

D. Service Support

1. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

E. Manufacturer's Nameplate

1. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, serial number, shop order number, and date of manufacture securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

F. UL 508 Certification

1. All control panels furnished shall conform to the requirements of UL508A. A UL508A label shall be fixed to the panel door.

2. All control panels shall also conform to requirements per NEC Article 409- Industrial Control Panels and NFPA 79 Electrical Standard for Industrial Machinery.

G. Installer Qualifications

1. The installer shall be a firm that is regularly engaged the construction of industrial facilities. The installer shall be a licensed electrical contractor / subcontractor who is familiar and complies with the latest issues of National Electrical Code (NEC), California Electrical Code (CEC), National Electrical Installation Standards (NEIS), and all State and local codes that pertain to installing electrical work. The installer shall also be familiar, and comply with, the standard requirements of the power and communications utilities in the area. The installer shall be familiar with NFPA 820 and the installation practices for classified locations.

H. Standards, Codes, Permits, and Regulations

1. Perform work; furnish, install, and test materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

a. Local Laws and Ordinances

b. State and Federal Laws

c. California State Fire Marshal (CSFM)

d. California Fire Code (CFC)

e. Titles 8, 19, and 24 of the California Code of Regulations (CCR)

f. National Fire Protection Association (NFPA)

g. Underwriters' Laboratories (UL)

h. National Electrical Safety Code (NESC)

i. American National Standards Institute (ANSI)

j. National Electrical Manufacturer's Association (NEMA)

k. National Electrical Contractors Association (NECA) Standard of Installation

l. Institute of Electrical and Electronics Engineers (IEEE)

m. Insulated Cable Engineers Association (ICEA)

n. Occupational Safety and Health Act (OSHA)

o. InterNational Electrical Testing Association (NETA)

p. American Society for Testing and Materials (ASTM)

q. California Electrical Code (CEC)

r. NFPA 70, National Electrical Code (NEC)

s. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities

t. Electrical Testing Laboratories Inc (ETL)

2. Conflicts, if any that may exist between the above items will be resolved at the discretion of the Engineer.

3. Wherever the requirements of the specifications or drawings exceed those of the above items, the requirements of the specifications or drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

4. Obtain all permits and pay all fees required by any governmental agency or utility having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.3 SUBMITTALS

A. General

1. Provide manufacturers' descriptive information and shop drawings for all equipment, material, and devices furnished under Division 26, Electrical including certified outline and arrangement drawings, schematic (elementary) diagrams, interconnection and connection diagrams, in accordance with Section 01 33 00, Submittals and this section. Device designations and symbols for schematic (elementary) connection or interconnection diagrams shall conform to the latest edition of NEMA ICS l.

2. Submit complete interface schematic drawings for all equipment furnished in accordance with other Divisions (23, 27, 28, 33, 40, 43, etc.) that interface with electrical equipment. These drawings shall contain diagrams, terminal numbers, device names, tag numbers, control cable conductor colors and numbers, etc., to provide complete identification of the circuits and provide coordination between the equipment.

3. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.

4. Submittal shop drawing formats:

   a. Shop drawings shall be submitted in accordance with Section 01 33 00.

B. Submit certified shop drawings and diagrams as follows:

1. Layouts indicating conformity with space requirements

2. Assembly drawings in sufficient detail to identify every part of the specified equipment including bills of material

3. Detailed panel, cubicle, and structure layout drawings showing the principal dimensions of the equipment, the location of all devices therein, and the size of electrical conduits and connections.

4. One-line, three-line, schematic (elementary), connections detailing all internal wiring, and interconnection diagrams detailing all field wiring.

5. Control schematics shall use the ladder diagram type format incorporating line number, operation function statement, contact location line number with an underline for a normally closed contact, a description of operation of each device and complete step-by-step written sequence of operation. Wire and terminal numbers shall be clearly shown. Actual device symbols shall be used to represent equipment such as limit switches, level switches, pressure switches, time delay relays, etc. Control schematics shall be shown with the electrical system in a de-energized state. Refer to the schematic (elementary) diagrams in the contract drawings for examples. Refer to District's Standard Drawing STD-E-001 for device symbols and General Notes. Each motorized equipment shall be provided with a control schematic diagram with equipment tagname. A typical motor control schematic shall not be allowed.

6. Complete interconnection diagram for each system showing every wire by number, every junction terminal box or device to which it connects from origination to final destination, and boxes, manholes, pull boxes, and cabinets through which it passes. These diagrams shall show wiring installed by Contractor between items of manufactured, prewired or non-prewired equipment.

7. Furnish schematic (elementary) diagrams, including Contractor modifications, of all factory wired equipment and Contractor furnished equipment for District's approval and record purposes. These wiring diagrams shall indicate point-to-point wire terminations, and wire color identifications with tags per Section 26 05 19, Section 26 05 53, and as shown on drawings.

8. Characteristic curves for all protective devices.

9. Installation drawings for all electrical work showing conduit layout, conduit sizes and locations of equipment foundations, and details accurately dimensioned. Conduits located in foundation slabs or routed through concrete structures shall be indicated on the installation drawings and submitted for review prior to foundation concrete pour.

C. Seismic requirements:

1. Submit anchorage calculations for equipment listed below and equipment that weighs 200 pounds or greater. Calculations shall be based on requirements of Section 01 33 12.

2. The following electrical equipment shall be seismically anchored in accordance with Section 01 33 12:

a. Conduit and Instrumentation Racks (Section 05 12 00)

b. Process Control Panels (Section 40 95 13)

c. Air Compressor Motor Replacement (Section 22 05 00) (where MAC motor termination box is specified)

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Complete system functionality in accordance with the intent of these Contract Documents.

2. Coordinating the details of equipment layouts and construction for all Specification Divisions which affect the work covered under Division 26, Electrical.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide a complete functional system.

4. Coordination with including but not limited to: mechanical systems packaged with electrical equipment, medium voltage motors with motor protection controls.

5. Coordination with Division 40, Process Integration, for installation of plant control system including but not limited to: field instrumentation,

heat tracing, control networks and media converters, programmable logic controller and human machine interface, computers, and control panels.

1.5 INTENT OF DRAWINGS

A. The Contract drawings indicate the extent, general location, and arrangement of equipment. Duct bank and conduit runs are diagrammatic and may not show the exact locations for installation. The Contractor shall verify the locations of conduit stub-ups based upon conduit entry space of equipment furnished from the manufacturer's certified shop drawings and by inspection of the actual equipment to be installed.

B. Where it is necessary to connect to existing equipment, the existing equipment has been located as accurately as possible from record drawings. Exact location is not guaranteed. The contractor shall inspect existing conditions and determine exact locations as required. Variations from locations indicated will not be basis for additional compensation.

C. Existing underground equipment and piping in public areas and in the vicinity of work, including electric, communication, gas, water, etc. owned by other utilities/agencies shall be carefully verified and inspected prior to performing work. All equipment installations shall be incompliance with the requirements in accordance with the existing utilities in the vicinity of work.

D. In general, items shown on electrical drawings in black indicate electrical work under this construction contract unless noted otherwise. Items that are screened are existing facilities.

E. Standard details are typical for all locations which apply regardless of whether a callout is shown on the plan or not.

F. Electrical design is based on minimum horsepower and current ratings. If the manufacturer or Contractor provides equipment with a larger horsepower or current rating, the Contractor shall be responsible for making all necessary changes to accommodate the larger unit, with the approval of the Engineer. Contractor shall pay for all such changes including engineering design by a Professional Electrical Engineer currently registered in the State of California with an active license.

G. Number and size of wires which shall be installed in runs of conduit where not shown on the drawings shall be determined from the one-line, schematics, connection, interconnection, conduit schedule, and control diagrams of actual equipment furnished.

1.6 DEFINITIONS (APPLICABLE TO SPECIFICATIONS AND DRAWINGS)

A. Certified: Confirmed to be accurate, or as represented, or as meeting standards.

B. Concealed: Inside building above grade and located within walls, furred spaces, crawl spaces, attics, above suspended ceiling, etc. In general, any item not visible or directly accessible.

C. Connect: Complete hookup of item with required services, including conduits, wires, and other accessories.

D. Exposed: Either visible or subject to mechanical or weather damage, indoor or outdoor, include areas such as mechanical and storage rooms. In general, any item that is directly accessible without removing walls, panels, ceilings or other parts of structure.

E. Furnish: Supply and deliver complete.

F. Install: Place, secure and connect as required to make fully operational.

G. Provide: Furnish and install as defined above: perform work.

H. Use (verb): Furnish and install as defined above.

I. Wiring: Electrical conduit, raceway, conductors, and connections.

1.7 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Make requests for approval of alternatives in writing to the Engineer before submittals of shop drawings. Provide sufficient material or data to allow evaluation of the proposed alternative and determination of compliance with these Contract Documents. List any proposed deviations from these Contract Documents.

1.8 ELECTRICAL INSTALLATIONS

A. Electrical installations shall conform to ANSI C2, NEC, CEC, and requirements specified herein, and in the sections specifying the associated equipment materials, and systems. The most stringent code shall be followed.

B. Wiring and Conduit: Provide internal wiring for components of packaged equipment as an integral part of the equipment, where such wiring is not provided by the equipment manufacturer. Provide power, control, instrumentation and data wiring and conduit for field-installed equipment and wiring systems. A final set of drawing shall be included in all panels. Drawings shall depict schematics of field as-built conditions. Drawings shall be drafted in the Microstation or AutoCad format and printed in 11” x 17” size.

1.9 LOCKOUT REQUIREMENTS

A. Provide disconnecting means, capable of being locked out, for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with applicable requirements of CAL OSHA and Title 8 of the California Code of Regulations. All local disconnects shall be rated as shown on Contract Drawings.

B. Coordinate any lockout requirements with the District prior to disconnecting electrical service to process equipment.

1.10 ELECTRICAL CHARACTERISTICS

A. Electrical characteristics for this project shall include the following:

1. 4160V, 3-Phase, 3-Wire, 60Hz

2. 480 VAC, 3-Phase, 3-Wire, 60 Hz

3. 120 VAC, single-phase, three-wire, 60 Hz

4. 24 or 12 VDC.

B. Final connections to new equipment provided under this contract shall be in accordance with the manufacturer's recommendations. Final connections to the existing power distribution system shall be made to match existing condition or specified in the contract documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide all first-quality, new materials, and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide UL listed materials and equipment wherever standards have been established by that agency.

B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer.

2.2 STANDARD PRODUCTS

A. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

2.3 EQUIPMENT FINISH

A. Provide materials and equipment with manufacturers' standard finish system. Provide ANSI 61, light grey color or RAL 7035 (light gray) with Electrostatic Powder for all equipment unless otherwise specified in the individual equipment sections. Provide two quarts of touchup paint.

B. Provide standard manufactures brush finish for all stainless steel NEMA 4X enclosures.

2.4 ENVIRONMENTAL

A. Provide materials and equipment suitable for installation and operation under rated conditions at 200 feet above sea level and with maximum ambient temperature of 120°F (49°C).

2.5 OUTDOOR EQUIPMENT

A. Provide equipment and devices to be installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 32°F to 140°F. Equipment must be capable of proper operation at rated output continuously in this ambient temperature range in direct sun. Provide additional equipment such as enclosures, sunshades, and cooling equipment so that this performance requirement can be met.

2.6 FASTENERS

A. Fasteners for securing equipment to walls and floors shall be stainless steel.

2.7 ENCLOSURES

A. General

B. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in this Section, or as shown on the drawings. Electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, non-process indoor locations or as shown on the drawings.

2. NEMA 4X, SS316 for outdoor locations shown on the drawings. Stainless steel NEMA 4X enclosures shall be used in all outdoors locations and indoor wet locations including the main air compressor area. The back and sides shall be of one piece construction. Doors or covers shall be attached with 316 stainless steel or non-metallic captive fasteners or hinge pins. The cover-to-box joint shall be made watertight with a mechanically retained gasket.

PART 3 - EXECUTION

3.1 GENERAL

A. All work on this project is in outdoor environment. NEMA 4X, SS316 enclosures, pull boxes, and all associated mounting hardware shall be SS-316 materials. All associated mounting hardware shall be PVC coated rigid galvanized steel material.

B. Unless specified otherwise, electrical equipment and anchoring systems shall be designed to withstand seismic forces as specified in Section 01 33 12.

C. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance. Carry out work in accordance with NECA Standard of Installation unless otherwise specified.

D. Coordinate electrical work with the Engineer, with other trades, and work with various agencies and/or utilities to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.

E. Check the approximate locations of electrical outlets, equipment, underground utilities, and other electrical system components shown on drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify and provide recommended solution to the Engineer in writing. The Engineer's decision shall govern. Make modifications and changes required to correct conflicts.

F. In general, coordinate and notify District at least two weeks prior to all demolition work. Clean the equipment and the area prior to re-use the equipment and when the new work is in the same area. Wires that remain (to be reconnected) during demolition shall be protected in place during construction.

G. When conduit and wires are removed, watertight sealed, cap-off, and cover all conduit openings of all equipment including wall, control panel, junction box, pull box, T-Fittings, etc that remains.

3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturers' recommendations for storage. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, and indoor locations to prevent condensation. Energize all space heaters furnished with equipment or provide temporary heating, sufficient to prevent condensation, in transformers, switchgear, motors, motor control centers, and motor starters which do not have space heaters.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the Contractor's convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided that is acceptable to the Engineer. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction. Cap all spare conduits with pull rope.

C. The Contractor shall provide electrical insulating blankets to create a barrier between potentially energized conductors and workers when working in a confined space.

3.3 MATERIAL AND EQUIPMENT INSTALLATION

A. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between the manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's decision. Keep a copy of manufacturers' installation instructions at the jobsite for review at all times.

B. Use appropriate conduit and conductor fittings that maintain the specified enclosure environmental ratings after proper installation.

C. Minimum wire size for all 480VAC circuits shall be #12.

3.4 EQUIPMENT SUPPORTS

A. Provide equipment supports for all equipment in accordance with the manufacturer’s requirements. Free standing panels and enclosures shall be mounted on concrete pads that are of the same plan dimensions as the equipment furnished unless otherwise shown on the drawings. Provide leveling channels under all equipment with roll out or drawout circuit breakers or contactors, located as recommended by the equipment manufacturer.

3.5 CUTTING AND PATCHING

A. Lay out work carefully in advance. Do not cut, drill, or notch any structural member or building surface without specific approval of Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Prior to drilling through walls, floors, or any concrete slab member, perform non-destructive x-ray to locate supporting rebar. Following such work, restore surfaces neatly to original condition. Use only skilled craftsmen of the trades.

3.6 CLEANING AND TOUCHUP PAINTING

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the Engineer.

B. The interior of all electrical equipment, including windings of dry type transformers, shall be vacuumed, and wiped free of dust just before final acceptance. De-energization of equipment for cleaning and touchup painting shall be coordinated with the District.

3.7 INSPECTION

A. Allow materials, equipment, and workmanship to be inspected at any time by the Engineer and District or their representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer.

3.8 SERVICE CONTINUITY

A. Maintain continuity of electric service to all functioning portions of the plant. Make no outages without prior written authorization of the Engineer. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work. Refer to Section 01 35 13 for additional requirements.

3.9 TEMPORARY ELECTRIC POWER

A. Refer to Section 01 50 00 for necessary provisions for electric power used during construction.

B. The Contractor shall provide temporary lighting for all trades within the buildings. The average lighting level (footcandle) shall meet OSHA and CAL-OSHA requirements.

3.10 TESTS

A. Perform testing as specified in Sections 01 75 17 and 26 08 00.

3.11 CIRCUIT BREAKER TESTING AND THERMOGRAPHIC SURVEY

A. The Contractor shall perform circuit breaker testing and thermographic survey as specified under this section.

B. The Contractor inspection and test procedures shall comply with the latest NETA Acceptance Testing Specifications.

C. The Contractor shall record and provide all surveys, tests, calibrations, inspections, adjustments, services, and corrective actions taken. Reports shall include test equipment manufacturer name, model number, and date of last calibration. Submit Field Test Report within five (5) days after performing the test to the District.

D. The Contractor shall provide a thermographic survey report including scan pictures, cause of the problems (if any), and recommendations for corrective procedures as required.

E. Calibration dates of testing equipment shall be within one (1) year of the date of testing. Provide calibration record of all test equipment along with the final report.

F. The Contractor shall provide sticker at the location of the tested equipment. Sticker shall indicate equipment as satisfactorily tested and acceptable for service, date of testing, and name of tester.

G. Table 1 is a summary of equipment/systems that require circuit breaker testing and thermographic survey. Additional testing may be required when specified elsewhere.

Table 1: Testing Summary (Additional tests may be required in other specification sections)			
System/Equipment Name	Associated Circuit Breaker/Relay or Component	Circuit Breaker/Relay Test Required	Thermographic Survey Required
Switchgear S-3	Main breaker for Bus A and Bus B and Tie Protection Relays	NETA	No
U10, U11, U10-U11 Tie	Breakers	NETA	No
Main Air Compressor Motor (Qty 4)	Motor Protection Termination Box	N/A	Yes
MCC-P15	Main breaker and all feeder breakers	NETA	Yes
MCC-P16	Main breaker and all feeder breakers	NETA	Yes
MCC-P17	Main breaker and all feeder breakers	NETA	Yes
Main Air Compressor Motor Starter (Qty 4)	New MV Cable lug connection	N/A	Yes

3.12 JOB SAFETY BRIEFING

A. Prior to the start of the project, conduct a joint District and Contractor job safety briefing to cover hazards associated with the job, work procedures involved, energy source controls, and associated special precautions.

B. Provide a record of the meeting and attendance to the Engineer within five (5) days after the briefing.

END OF SECTION

SECTION 26 05 13

MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: This section covers the work necessary to furnish and install complete and operable medium voltage cable systems as specified herein.

B. Related Sections:

1. Refer to other divisions and sections of these Specifications to determine the extent and character of related electrical work specified elsewhere, but which shall be done under this section.

2. Section 26 08 00 – Commissioning of Electrical Systems

3. Section 26 05 00 – Common Work Results for Electrical

4. Section 26 05 26 – Grounding and Bonding for Electrical Systems

5. Section 26 05 53 – Identification of Electrical Systems

1.2 QUALITY ASSURANCE

A. The manufacture of the cables shall supply written evidence of demonstrating a minimum of 15 years of United States production experience in triple extrusion of EPR insulation in medium voltage cable construction, and shall in-house formulate and mix all insulating and semi-conducting compounds used in the cable construction.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittals, and Section 26 05 00, Common Work Results for Electrical.

B. Submit pulling calculations for all medium voltage cables installed in concrete ductbanks showing compliance with all manufacturers' recommended installation requirements and pulling tensions. Submittal shall include the recommended sequence of cable installations specifically detailing the "from" and "to" points for each cable installation segment.

C. Submit X-Y plots showing discharge levels recorded during the corona discharge test performed per AEIC requirements on the conductors supplied.

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. B-3 - Standard Specification for Soft or Annealed Copper Wire.

2. B-8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B-496 – Standards for annealed uncoated copper compact stranded.

B. Insulated Cable Engineers Association (ICEA)

C. California Electrical Code (CEC):

1. Article 326 - Medium Voltage Cable: Type MV.

D. National Electrical Manufacturers Association (NEMA)

E. Underwriters Laboratory (UL):

1. UL 1072

F. Institute of Electronic and Electrical Engineers (IEEE):

1. IEEE 383

2. IEEE 1202

1.5 CONDUCTOR COLOR CODING

A. Color coding of multiconductor control and instrumentation cable is specified in the individual cable type specification.

B. For power conductors, provide all single conductors and individual conductors of multiconductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding to indicate phase A, B or C by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location at all conductor termination and pulling points.

C. Phases A, B, C implies the direction of positive phase rotation.

D. Use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
5 and 15kV	Cable Phasing	Identify by tagging each phase after taping has been completed
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

1.6 DELIVERY, STORAGE AND HANDLING

A. Storage of cable after pulling shall include purging of entire cable with nitrogen or otherwise seal with tape at both ends.

B. The Contractor shall inspect the reels as they are unloaded from the delivery truck, any visible damage shall be reported by the Contractor and the reel returned to the factory.

C. The Contractor shall provide a crane, special lift truck or forklift to unload the cable reels.

D. Cables shall be packaged on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

E. All conductor ends shall be sealed at the factory, and these seals shall be intact when the conductors are delivered. When delivered, provide the Engineer with certified test reports verifying that the supplied conductors passed applicable AEIC CS6 and ICEA tests. Provide the Engineer with copies of the original X-Y plots showing discharge levels recorded during the corona discharge test performed per AEIC requirements on the conductors supplied.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the Division 01, General Requirements.

2.2 CONDUCTORS

A. 5kV (Type 8) and 15 kV (Type 9) Conductors:

1. Newly manufactured (not more than 12 months old) of soft drawn copper with not less than 97 percent conductivity, with size, grade of insulation, voltage, UL listing, date of manufacture, and manufacturer's name permanently marked on outer covering at not more than 2 feet 0 inch intervals.

2. Identify and mark conductors in accordance with CEC Article 310.

3. Cable shall meet requirements of ICEA, NEMA, and AEIC.

4. Suitable for use in partially submerged, non-metallic or metallic underground duct.

5. Rated for 105 degree C continuous operation, 140 degree C emergency, and 250 degree C short-circuit.

6. Flame, oil, acid, alkali, UV and ozone resistant.

7. Single-conductor, compact stranded Class B annealed copper.

8. Covered with an extruded semi-conductor EPR strand screen, 220 mil ethylene propylene rubber insulation for 15kV and 115 mil for 5kV rated cable, extruded EPR semi-conducting insulation screen, 5 mil bare copper shielding tape with 25 percent minimum overlap, and 80 mil (minimum) chlorosulfonated polyethylene (CSPE) jacket.

9. Cable UL listed as Type MV-105.

10. 133 percent insulation level.

B. Acceptable Manufactures

1. Okonite, Okoguard – Okolon

2. Kerite, PermaShield

3. Or equal.

2.3 MEDIUM VOLTAGE TERMINATION KITS:

A. Provide terminators rated in accordance with IEEE 48, Class 1.

1. Use terminations consisting of a high dielectric constant stress control tube insulated with a nontracking silicone rubber insulator, prestretched and loaded together onto a removable core.

2. Use heat shrinkable cable terminations in factory engineered kit form, capable of properly terminating cable specified in this Section. Kits must be compatible with MV-105 cable rated for 105 degrees C normal operating temperature and 250 degrees C emergency overload temperature. Provide skirted EPDM type or preassembled porcelain slip-on type for outdoor terminations.

3. For all terminations provide proper shield termination and grounding suitable for single-conductor, EPR insulated and shielded cable of the size indicated on the drawings. Provide all necessary mounting hardware, covers, and connectors.

4. For cable to bus connection kits, use heat-shrinkable insulating tubing and sealant strips for insulating and environmentally sealing medium-voltage in-line cable to busbar connections.

5. Acceptable Manufactures:

   a. Single Conductor Termination Kit: Raychem, HVT-Z or equal.

   b. Cable to Bus Connection Kit: Raychem, HVBC or equal.

2.4 MEDIUM VOLTAGE CONDUCTOR ARC AND FIREPROOFING MATERIALS:

A. Arc and fireproofing tape: Arc and fireproofing tape shall consist of a flexible conformable unsupported elastomer. The tape shall be not less than 30 mils (0.030 inches) thick and be capable of over 100 percent elongation. The tape shall be non-corrosive to metallic cable sheaths and compatible with synthetic cable jackets such as hypalon (CSPE) and PVC. The tape shall be self-extinguishing and shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage.

   1. Acceptable Manufactures:

      a. 3M Scotch 77 Fire and Arc Proofing Tape

      b. Plymouth Rubber Company 53 Plyarc Arc and Fire Proofing Tape

      c. Or equal.

B. Glass Cloth Electrical Tape: Glass cloth electrical tape shall consist of a woven glass fabric tape with a thermosetting rubber based pressure sensitive adhesive. The tape shall be not less than 7-mils (0.007 inches) thick, and shall have high tensile strength.

1. Acceptable Manufactures:

    a. 3M Scotch 69 Glass Cloth Electrical Tape

    b. Plymouth Rubber Company 77 Plyglas Pressure Sensitive Glass Cloth Tape

    c. Or equal.

C. Flexible Cord and Cable Sealing Fittings:

1. Provide liquid-tight strain relief connectors for exposed flexible cord and power cable where cables enter electrical panels and enclosures. Connectors shall be OZ Gedney, Hubbell, Appleton, or equal as approved by the Engineer.

D. Electrical Tape for Color Coding:

1. Electrical tape shall be premium grade, not less than 7 mils thick, rated for 90 degree C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

2. Acceptable Manufactures:

    a. 3M 35 Scotch Vinyl Electrical Tape for Color Coding

    b. Plymouth Rubber Company Premium 37 Color Coding Tape

    c. Or equal.

E. Pulling Lubricant

1. Cable pulling lubricant shall be a water-based gel and be compatible with all cable jacket types. The lubricant shall be UL listed and contain no waxes, greases, silicones or polyalkylene glycol oils or waxes.

2. The lubricant shall be specification-grade that does not promote flame propagation when used with fire-retardant cables.

3. Acceptable Manufactures:

    a. Polywater Lubricant J

    b. Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket, voltage rating, and with the raceway involved.

B. Submit a schedule of cable pulls 2 weeks prior to installation and certify in writing that the cable will meet the requirements of the cable manufacturer for maximum pulling tension, allowable sidewall pressure, and installed bending radius limitations.

C. Cables shall not be installed into raceways until the Contractor prepared pulling calculations are reviewed by the Engineer and returned marked as “No Exceptions Noted.”

D. Monitor pulling tensions using a dynometer while pulling on runs between manholes and handholes and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

E. Pulling of cable shall be performed in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. If cable is laid on ground during pulling, cable shall be wiped free of sandy or gritty material prior to entry of cable into conduit and prior to application of any pulling compound.

F. Properly coat wires and cables with pulling compound recommended by cable manufacturer before pulling into conduits and prevent mechanical damage to conductors during installation. Provide compounds that are not injurious to the cable and wire jackets and do not harden or become adhesive.

G. Other lubricants substituted must be accompanied by a statement from conductor manufacturer as to its acceptable use with conductors being installed.

H. Do not exceed pulling tension and side-wall pressures based on Hypalon jacket or CSPE, PVC conduit and lubricant coefficient of friction. Pull boxes located as indicated on the Drawings are based on nominal pulling tension and side-wall pressures. Install additional pull boxes as required to meet cable manufacturer's recommendations.

I. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the CEC and UL.

J. Where single conductors and cables in manholes, handholes, vaults, and other indicated locations are not wrapped together by some other means such as arc and

fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

K. Splices:

1. Splicing of cables is not allowed. All cables shall be of one continuous length between the source and destination.

L. Insulate and seal each cable-to-bus termination with heat shrinkable bus connector kits.

M. Shielded cables shall have the shields connected to ground test stations in manholes where splices occur. Where shielded cables have end points or terminations the shields shall be grounded to bus bars in enclosures.

N. In manholes, underground raceways, and other outdoor locations:

1. Seal the cable ends prior to pulling them in to prevent the entry of moisture.

2. Use bags of epoxy resin which are not less than 6 mm (1/4 inch) larger in diameter than the overall diameter of the cable. Clean each end of each cable before installing the epoxy resin over it.

O. Electrical Identification: As specified in Article 3.2. Position the tags so they will be easy to read after the fireproofing is installed.

P. Splices will not be permitted except as accepted in writing by the Engineer.

Q. Make all terminations with high voltage termination kits in accordance with manufacturer's instructions.

R. Identify all circuits in accordance with the conductor identification system specified at switchgear, manholes, motor starters, primary substation transformers, terminations, etc.

S. Provide terminals or connectors acceptable for the type of conductor material used.

3.2 LACING OF WIRES AND CABLES

A. All wires and cables shall be tagged and laced in pull or junction boxes, manholes, handholes, wireways, and at each termination. Each wire and cable shall be tagged at least once as it passes through each pull or junction box, manhole, handhole, and at each termination. Each wire and cable shall be tagged at least once as it passes through wireways . Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit and the laced-together circuit or cable shall be tagged with the cable number. All wiring

entering and exiting the control panels shall be bundled into groups. Power, lighting, control, alarm, annunciator, and instrumentation wiring shall be bundled, and laced as specified herein.

3.3 ARC AND FIREPROOFING TAPES

A. Use arc and fireproofing tapes on all 5 and 15kV cables at all terminations, splices, manholes, handholes and junction boxes.

B. Wrap together as a single cable all conductors entering from each conduit. Wrap using one-half lapped layers of the tape.

C. Apply the tape in a single layer, one-half lapped or as recommended by the manufacture. Install the tape with the coated side towards the cable and extend it not less than 25mm (1 inch) into each duct. Secure the tape in place by a random wrap of glass cloth tape.

D. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

3.4 FIELD QUALITY CONTROL

A. Perform high potential tests on all cables after installation. All medium voltage conductor testing shall be performed per the requirements of Section 26 08 00 and the NETA guidelines.

END OF SECTION

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SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: This section covers the work necessary to provide a complete and operable low voltage cable system as specified herein.

B. Related Sections: Refer to other divisions and sections of these specifications to determine the extent and character of related electrical work specified elsewhere, but which shall be done under this section.

1. Section 01 33 00 – Submittal Procedures
2. Section 26 05 00 – Common Work Results for Electrical
3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
4. Section 26 05 53 – Identification of Electrical Systems
5. Section 26 08 00 – Commissioning of Electrical Systems
6. Section 27 13 23 Communications Optical Fiber Backbone Cabling
7. Section 27 13 23.13 Communications Optical Fiber Splice and Termination

1.2 SUBMITTALS

A. Make submittals in accordance with Section 01 33 00 Submittal Procedures, and Section 26 05 00 Common Work Results for Electrical. In addition to these requirements, submit the following:

1. Perform cable insulation and resistant tests in accordance to the NETA ATS latest version.
2. Pulling calculations for all low voltage cables installed in concrete ductbank showing compliance with all manufacturers' recommended installation requirements and pulling tensions. Submittal shall include the recommended sequence of cable installations specifically detailing the "from" and "to" points for each cable installation segment.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. B-3 - Standard Specification for Soft or Annealed Copper Wire.

2. B-8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B-33 – Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

B. American National Standards Institute (ANSI):

1. C2 - National Electrical Safety Code

C. Institute of Electronic and Electrical Engineers (IEEE):

1. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

2. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

D. Insulated Cable Engineers Association (ICEA):

1. S-73-532 – Standard for Control, Thermocouple Extension and Instrumentation Cables. (Join Standard NEMA WC 57)

2. S-95-658 – Standard for Nonshielded Power Cables rated 2000 Volts or less. (Joined Standard NEMA WC 70)

E. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code

F. National Electrical Manufacturers Association (NEMA):

1. WC 26 – Wire and Cable Packaging

G. InterNational Electrical Testing Association (NETA ATS)

H. Underwriters Laboratory (UL):

1. Standard 44 – Thermoset Insulated Wires and Cables

2. Standard 83 – Thermoplastic Insulated Wires and Cables

3. Standard 486A/486B – Wire Connectors

4. Standard 510 – Polyvinyl Chloride, Polyethylene and Rubber Insulating Tapes

5. Standard 1063 – Machine Tool Wires and Cables

6. Standard 1581 – Reference Standard for Electrical Wires, Cables and Flexible Cords

1.4 SYSTEM DESCRIPTION

A. The application for required cable, wire, and connectors include, but are not limited to:

1. Power distribution circuitry

2. Appliance and equipment circuitry

3. Network and communication systems and circuitry

4. Wiring for motors of mechanical equipment

5. Wiring from the motor(s) of mechanical equipment to disconnect switches or junction boxes, including wiring for pushbuttons, pilot lights, interlocks and similar devices as directed, shown, or specified.

6. Wiring from the motors of mechanical equipment to motor starters, including other auxiliary wiring as may be required, directed, or shown.

7. Line voltage wiring as required by other Disciplines, and interlocking to motor starters

8. Control wiring for motors, mechanical equipment, relays and switches, and similar mechanical-electrical devices.

1.5 CONDUCTOR COLOR CODING

A. Color coding of multiconductor control and instrumentation cable is specified in the individual cable type specification.

B. For power conductors, provide all single conductors and individual conductors of multiconductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location at all conductor termination and pulling points.

C. Phases A, B, C imply the direction of positive phase rotation.

D. Use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
208Y/120 Volts, 3-Phase, 4-Wire	Grounded Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
480Y/277 Volts, 3-Phase, 4-Wire	Grounded Neutral (if used)	White, Black Tracer
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
Single Conductor, AC		Red
Multiple Conductor Control Cables		ICEA Method 1 Table E-2
Multiple Conductor Power Cables		ICEA Method 1 or 3, Table E-2
12 or 24V DC Positive		Blue
0V DC		Blue with Gray Stripes
Single-Conductor, DC Alarm, Annunciator, Instrumentation, and Telemetering (if not shielded)		Purple

E. All conductors carrying AC foreign voltage over 100 VAC into control panels, switchboards, and other enclosures shall be yellow. Multi-conductor cables carrying such foreign voltage shall be marked with yellow tape at each termination point.

1.6 DELIVERY, STORAGE AND HANDLING

A. Storage of cable after pulling or splicing shall include purging of entire cable with nitrogen or otherwise seal with tape at both ends.

B. Inspect the reels as they are unloaded from the delivery truck. Any visible damage shall be reported by the Contractor and the reel returned to the factory.

C. Provide a crane, special lift truck or forklift to unload the cable reels.

D. Cables shall be packaged on spools or reels. Each package shall contain only one continuous length of cable. Construct the packaging so as to prevent damage to the cable during shipping and handling.

E. All conductor ends shall be sealed at the factory, and these seals shall be intact when the conductors are delivered. When delivered, provide the Engineer with certified test reports.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the Division 01, General Requirements.

2.2 CONDUCTORS

A. Provide cables as specified under the type number in this section (Type 1, Type 2, etc.). Conduits shown on the drawings have been sized to accommodate the outside diameter for each type.

B. Multi-Conductor Power, Control, and Instrumentation Cable 600 Volts and Less:

1. Provide cable that is UL listed and conforms to the requirements of UL 1277 and CEC Article 340, or UL listed Power Limited Circuit Cable that conforms to the requirements of Article 725 of the National Electrical Code. Provide cables permanently and legibly marked with the manufacturer's name, the nominal voltage, the type of cable, and the UL label (or submit evidence of UL listing).

2. Type 10 (600-Volt, Twisted, Shielded Pair Instrumentation Cable):

a. General: Type TC, single pair instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90 degrees C dry locations, 75 degrees C wet locations.

b. Individual Conductors: No.18 AWG stranded bare annealed copper, Class B, 7-strand concentric per ASTM B8, size as indicated on the drawings; 7-strand tinned copper drain wire.

c. Insulation and Jacket: Each conductor 15-mil nominal PVC and 4-mil nylon insulation. Pair conductors pigmented black and red. Jacket flame-retardant and sunlight- and oil-resistant PVC with 45 mil nominal thickness. Aluminum/polyester shield overlapped to provide 100 percent coverage.

1) Acceptable Manufacturers:

a) Belden No. 9341

b) Dekoron (MC-HL)

c) General Cable, VNTC Spec 2450 (for hazardous locations)

d) Okonite Okoseal-N Type P-OS (for hazardous locations)

e) Or equal.

C. Type 11 (Power and control cables 600 Volts and less):

1. Unless otherwise indicated, provide stranded conductors.

2. Provide the following types of insulation:

a. Type XHHW-2 insulation for conductors No.14 and larger.

3. Single conductor control wiring shall be No.14 AWG and shall have insulation type XHHW-2 and Class B stranded per ASTM B-8. Insulation shall be in accordance to ICEA S-95-658, NEMA WC-70, and UL listed.

4. XHHW-2 power conductors shall have a cross linked polyethylene insulation rated at 90 degrees C in wet and dry locations.

5. Provide copper conductors. Do not provide conductors smaller than those indicated.

6. Acceptable Manufactures:

a. Southwire, SIMpull Type XHHW-2

b. Okonite, X-Olene Type XHHW-2

c. Southwire, Spec 45061 (for hazardous locations)

d. Or equal.

D. Type 13 (Category 6 Unshielded Twisted Pairs):

1. General: industrial grade Category 6 Unshielded Twisted Pairs (UTP) suitable for use in harsh environments as industrial Ethernet cable, 600 MHz Enhanced Category 6, Gigabit Ethernet, 100BaseTX, NTSC/PAL Component or Composite Video, RS-422, RJ-45 compatible, suitable for outdoor use and installation in conduit and other approved raceways.

2. Conductors: 4 pairs of conductors, 8 conductors total, 23 AWG solid bare copper conductors.

3. Insulation and Jacket: polyolefin insulation, individual conductors colored white/green and green, white/orange and orange, white/blue and blue, and white/brown and brown, center strength member, unshielded, industrial grade sunlight and oil resistant PVC jacket, outer jacket ripcord, 0.251 x 0.339 inch overall nominal diameter, 300 volts, -40 degrees C to +75 degrees C operating temperature.

4. Applicable Standards: CEC/UL CMR, UL Style 444, ANSI/TIA/EIA-568-B.2-1 CAT 6, UL Verified to Category 6, UL1666 Riser Flame Test.

5. Acceptable Manufacturers:

   a. Belden 7927A

   b. AlphaWire, Xtra-Guard industrial Ethernet cable

   c. General Cable Cat 6 Riser

   d. Or equal.

E. Type 14 (600Volt Multi-twisted Shielded Pairs with a Common Overall Shield Instrumentation Cable):

1. General: Type TC, twisted, shielded pairs of instrument cables, grouped in a single cable, designed for use for instrumentation, process control, and computer applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90 degrees C dry and wet locations.

2. Conductors: No. 18 stranded bare annealed copper, Class B, 7-strand, concentric per ASTM B8. Tinned copper drain wires sized as shown on the drawings, one for each pair and one for the overall group.

3. Insulation and Jacket: Each conductor 15-mil PVC and 4-mil nylon insulation. Pair conductors pigmented black and red or black and white, with red or white conductor numerically printed for group identification.

Outer jacket flame-retardant and sunlight- and oil-resistant PVC with 45 mil minimum thickness. Individual pair shield aluminum/polyester. Group shield aluminum/polyester, overlapped for 100 percent coverage.

4. Acceptable Manufacturers:

   a. Belden No. 1050A (1 pair), 1048A (2 pairs), 1049A (4 pairs), 1050A (8 pairs)

   b. Dekoron (MC-HL)

   c. General Cable, Spec 2500 (for hazardous locations)

   d. Okonite Okoseal-N Type SP-OS (hazardous locations)

   e. Or equal.

F. Type 15 (6/C RS-485):

1. General: industrial low-capacitance shielded cables for EIA RS-485 applications, including security access card readers, suitable for outdoor use and installation in conduit and other approved raceways.

2. Conductors: 3 pairs of conductors, 6 conductors total, 22 AWG, 7 strand tinned copper conductors.

3. Insulation: foam high density polyethylene insulation, pairs colored white/blue and blue/white, white/orange and orange/white, white/green and green/white.

4. Shield: aluminum foil polyester tape providing 100 percent coverage, tinned copper braid providing 90 percent coverage, 7-strand tinned copper 24 AWG drain wire.

5. Jacket: UV and oil resistant PVC, 0.420 inch overall nominal diameter, 300 volt, -20 degrees C to +60 degrees C operating temperature.

6. Applicable Standards: CEC/UL CM and PLTC OIL RES II, UL 1685 Flame Test, UL 1581 Sunlight Resistance Test.

7. Acceptable Manufacturers:

   a. Belden 3108A

   b. Or equal.

G. Type 19 (600-Volt Multi-Conductor Control Cable):

1. General: Multi-conductor control circuit interconnection cable with ground. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating 90 degrees C dry and wet locations.

2. Individual Conductors: size as indicated on the drawings. Class B stranded per ASTM B-8.

3. Insulation and Jackets: Provide Cross-linked Polyethylene (XLPE) overall jacket insulation and Type XHHW-2 insulated conductor, and UL listed for cable tray use. Color code the conductor group in accordance with ICEA S-73-532 NEMA WC 57, Method 1, Table E-2. Provide cable with overall outer XLPE jacket which is flame-retardant, sunlight- and oil-resistant in accordance to UL 1581 and UL 1685.

4. No. 14 AWG minimum stranded copper conductors.

5. Acceptable Manufacturers:

   a. General Cable Type CVTC spec 4500 (for hazardous and non-hazardous locations)

   b. Okonite Okoseal-X-Olene (for hazardous and non-hazardous locations)

   c. Or equal.

H. Type 27 (600-Volt, Multi-twisted Shielded Triads with a Common Overall Shield Instrumentation Cable):

1. General: Twisted, shielded triads of instrument cables, grouped in a single cable, designed for use for instrumentation, process control, and computer applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90 degrees C dry and wet locations.

2. Conductors: No. 18 AWG stranded bare annealed copper, Class B, 7-strand, concentric per ASTM B8, size as indicated on the drawings. Tinned copper drain wires, one for each triad and one for the overall group.

3. Insulation and Jacket: Each conductor 15-mil PVC and 4-mil nylon insulation. Triad conductors pigmented black, red, and blue, or black, white, and red, with red or white conductor numerically printed for group identification. Outer jacket flame-retardant and sunlight- and oil-resistant PVC with 60 mil minimum thickness. Individual triad shield 1.35-mil

aluminum/polyester. Group shield 2.35-mil aluminum/polyester, overlapped for 100 percent coverage.

4. Conductors shall be numerically printed for group identification.

5. Acceptable Manufacturers:

   a. Belden

   b. Dekoron

   c. General Cable Spec 2450 (for hazardous locations)

   d. Okonite Okoseal-N Type P-OS (for hazardous locations)

   e. Or equal.

I. Flexible Cord and Cable Sealing Fittings:

1. Provide liquid-tight strain relief connectors for exposed flexible cord and power cable where cables enter electrical panels and enclosures.

2. Acceptable Manufacturers:

   a. OZ Gedney

   b. Hubbell

   c. Appleton

   d. Or equal.

J. Electrical Tape for Color Coding:

1. Electrical tape shall be premium grade, 600V rated, not less than 7 mils thick, rated for 105 degree C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

2. Acceptable Manufactures:

   a. 3M 35 Scotch Vinyl Electrical Tape for Color Coding

   b. Plymouth Rubber Company Premium 37 Color Coding Tape

c. Or equal.

K. Low Voltage Splices, 600 volts and below:

1. General: Provide low voltage splices consisting of 600 volt compression type connectors and connector insulators, suitable for indoor and outdoor field installations.

2. Provide two-way, uninsulated, compression connectors, long barrel type, suitable for use with stranded copper conductors. Provide UL listed connectors rated 600 volts minimum.

a. Acceptable Manufacturers:

1) Burndy

2) Thomas and Betts

3) Panduit

4) Or equal.

3. For 480V and below applications, connector insulators shall be cold shrink type factory expanded and assembled tubular rubber sleeves, suitable for field installation including direct buried, overhead, and outdoor applications. Insulators shall shrink over in-line connections, forming a water-proof seal. Provide insulators rated for 1000 volts, minimum, with -40 to 194 degree F temperature rating and ANSI C119-1 compliance.

a. Acceptable manufacturers:

1) 3M 8420 and 8430 Series for wires size #8 or larger, 3M Scotchcast 72-N Series for wire sizes #22-10.

2) Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket, voltage rating, and with the raceway involved.

B. Submit a schedule of cable pulls 2 weeks prior to installation and certify in writing that the cable will meet the requirements of the cable manufacturer for

maximum pulling tension, allowable sidewall pressure, and installed bending radius limitations.

C. Monitor pulling tensions while pulling on runs between manholes and handholes and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

D. Perform pulling of cable in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. If cable is laid on ground during pulling, cable shall be wiped free of sandy or gritty material prior to entry of cable into conduit and prior to application of any pulling compound.

E. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the CEC and UL.

F. Where single conductors and cables in manholes, handholes, vaults, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

G. Terminate no more than two control conductors per terminal point. Terminate all spare conductors on terminal blocks.

H. Low voltage power and control conductors shall be in separate conduits.

I. Only combine conductors with no more than two wire sizes difference to prevent possible installation damage to the smaller conductors; otherwise use separate conduits.

3.2 CONDUCTOR 600 VOLTS AND BELOW

A. Provide conductor sizes indicated on drawings with no splices except as accepted in writing by the Engineer.

B. Minimum wire size for all 480VAC or higher application shall be #12.

C. Wire nuts may be used on 120-volt lighting and 120-volt receptacle circuits only. Place no more than one conductor in any single-barrel pressure connection. Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

D. Soldered mechanical joints insulated with tape will not be acceptable.

E. Color coding on wire sizes larger than No. 6 AWG shall be by taping the individual conductors with the appropriate colored self-adhesive vinyl electrical tape. Vinyl plastic insulating tape for wire and cable splices and terminations shall be flame retardant, 7-mil thick minimum, rated for 105 degrees C minimum meeting the requirements of UL 510.

F. Provide terminals and connectors acceptable for the type of material used.

G. Arrange wiring inside control panels, motor starters, switchgear, etc., neatly cut to proper length, remove surplus wire, and bridle and secure in an acceptable manner. Identify all circuits entering switchgear, motor starters, control panels, etc., in accordance with the cable schedules on the drawings. Terminate cable conductors on the same side of the terminal blocks as shown on the drawings.

H. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate all control and instrumentation wiring (except solid thermocouple leads) with insulated, locking-fork compression lugs, Thomas & Betts Sta-Kon, or equal. Control panel incoming field wireway sizes indicated on the drawings are considered minimum. Contractor shall adjust wireway sizes to meet CEC percentage fill requirements.

I. For terminals designed to accept only bare wire compression terminations use only stranded wire, and terminate only one wire per terminal. Tighten all terminal screws with torque screwdriver to the recommended torque values.

J. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

K. Cap spare conductors and conductors not terminated with UL listed end caps. Label spare conductors with “From A – B, Spare – X” where A and B indicate the source and destination locations respectively and X shall be the unique spare sequence number.

L. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.

M. For conductors that will be connected by others, provide at least 6 feet spare conductor in freestanding panels and at least 2 feet spare in other assemblies. Provide additional spare conductor length in any particular assembly where it is obvious that more conductor length will be needed to reach the termination point.

N. Train cables passing through all manholes and handholes along the walls on cable racks. Allow minimum 5 feet of slack in each run in a "drip loop" at least once along a wall. Loops and cables shall be organized, trained, and neatly installed.

O. Do not strip cables more than eight inches from the nearest termination point of that cable.

P. Bundle and label all spare pairs with the cable designation. Tag all individual pairs to enable identification of spare pairs when making future terminations.

Q. Splices will not be permitted except as accepted in writing by the Engineer.

R. Ends of cable shall not be exposed to environment more than 24 hours after pulling or splicing. After 24 hours purge the cable with nitrogen or sealed with tape.

S. All hardware used shall be minimum rated for grade #5.

T. Used only rated compression lugs for all conductor terminations.

3.3 MULTI-CONDUCTOR POWER, CONTROL, AND INSTRUMENTATION CABLES 600 VOLTS AND LESS

A. Splices will not be permitted except as accepted in writing by the Engineer.

B. Where connections of cables installed under this section are to be made under Div. 40, Process Integration, leave pigtails of adequate length for neat bundled type connections.

C. Maintaining the integrity of shielding of instrumentation cables is essential to the operation of the control systems. Take special care in cable installation to ensure that grounds do not occur because of damage to the jacket over the shield. Shields shall be grounded at one location only as shown on the drawings.

3.4 LACING OF WIRES AND CABLES

A. Lace all wires and cables in pull or junction boxes, manholes, handholes, wireways, and at each termination. Lace wires and cables so that the wires of the individual circuits are laced together by circuit and the laced-together circuit or cable shall be tagged with the cable number. Bundle all wiring entering and exiting the control panels into groups. Bundle and lace power, lighting, control, alarm, annunciator, and instrumentation wiring as specified herein.

3.5 FIELD QUALITY CONTROL

A. Provide acceptance testing of all of the low voltage cables per Section 26 08 00.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included

1. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the California Electrical Code (CEC), as shown on the drawings and as specified herein.

2. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the CEC. Minimum sizes shall be No. 12 AWG.

3. Provide grounding bus bars and conductors where shown on the drawings.

B. Related sections

1. Section 01 33 00 – Submittal Procedures

2. Section 01 35 24 – Project Safety Requirements

3. Section 26 05 00 – Common Work Results for Electrical

4. Section 26 05 13 - Medium Voltage Cables

5. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables

6. Section 26 05 33 - Raceways and Boxes for Electrical Systems

7. Section 26 05 53 – Identification of Electrical Systems

8. Section 26 08 00 – Commissioning of Electrical Systems

1.2 QUALITY ASSURANCE

A. All grounding and bonding products shall be UL listed.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures, and Section 26 05 00, Common Work Results for Electrical. In addition to these requirements, provide the following:

1. Shop drawings

    a. Submit as-built drawings, include any grounding system installation.

2. As-built documents and Operation and Maintenance (O&M) manuals per the requirements of Section 01 33 00.

1.4 REFERENCES

A. American California Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE Std 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

B. American Society for Testing and Materials (ASTM)

1. B 3 – Standard Specification for Soft or Annealed Copper Wire.

2. B 187 – Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.

3. B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

4. B 418-95a Type II – Standard Specification for Cast and Wrought Galvanic Zinc Anodes.

C. California Code of Regulations

1. Title 24, Part 3 – California Electrical Code (CEC), Article 250 (Grounding).

D. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE Std 80 – IEEE Guide for Safety in AC Substation Grounding.

2. IEEE Std 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

E. Underwriters Laboratories (UL)

1. 467 – UL Standard for Grounding and Bonding Equipment.

2. 224 – UL Standard for Extruded Insulating Tubing.

F. Canadian Standards Association (CSA)

1. CAN/CSA-C22.3 No. 6-M91 – Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines.

G. InterNational Electrical Testing Association (NETA)

1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. National Association of Corrosion Engineers (NACE)

1. RP0177 – Mitigation of Alternating Current & Lightning Effects on Metallic Structures and Corrosion Control Systems.

1.5 DESIGN CRITERIA

A. Equipment grounding conductor sizing

1. Include a Type 11 insulated copper ground wire as specified in Section 26 05 19 in every power conduit or multi-conductor cable that supplies power to motors. The ground cable shall be the same size as the power cable up to size 2 AWG. After 2 AWG, the ground may be reduced to half the size of the power cable as long as 2 AWG is the smallest size selected when the ground cable is smaller than the power cable.

2. Provide grounding conductor for the motor surge protection devices located in the MAC motor termination box as shown on the Drawings and indicated in the Conduit and Cable schedule.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Direct-buried, concrete encased, and exposed grounding conductors

1. Bare concentric stranded copper conductors conforming to ASTM B-8 with Class B stranding, size as indicated on the drawings.

2. Acceptable manufactures:

a. Southwire

b. General Cable

c. Or equal.

B. Conduit grounding bushings

1. Insulated, 150 degree Celsius, malleable iron type with a solderless set-screw lug.

2. Acceptable manufacturers:

a. Appleton

b. Hubbell Electrical Products (Raco)

c. Or equal.

C. Grounding system connections:

1. Accessible connections to equipment, connections to structural steel, connections to reinforcing steel

a. Make mechanical connections to equipment, structural steel, and other accessible connections using one or two hole compression copper lugs as required for the cable size specified.

b. Make mechanical connections to reinforcing steel using UL 467 listed irreversible crimp compression copper connectors with the "run" and "tap" sizes as required for the reinforcing steel and cable size, respectively, specified. Connectors shall be factory prefilled with moisture inhibiting compound.

c. Acceptable manufacturers:

1) Harger

2) Burndy

3) Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 INSTALLATION

A. General

1. Metal conduits stubbed into power distribution equipment, control panels, or other enclosure shall be terminated with insulated grounding bushings and bonded to the enclosure's ground bus. Size the bonding wire in accordance with the CEC, except that a minimum No. 12 AWG shall be used.

2. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, cable tray, exposed structural steel and all other equipment and materials required by the CEC to be grounded, shall be grounded and bonded in accordance with the CEC.

3. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

4. Install equipment grounding conductors with all feeders and branch circuits. Each circuit shall have a dedicated equipment grounding conductor from source to load without splicing or “tee tapping” (e.g., three different receptacle circuits in a common home-run conduit back to a lighting panelboard shall have three separate equipment grounding conductors back to the lighting panelboard).

5. Instrumentation shield grounding shall be dedicated and terminated at the controller side.

B. Ground connections

1. Ground transformer neutrals, UPS neutrals, and other separately derived sources to the nearest GTS. Size the grounding electrode conductor in accordance with the CEC unless otherwise specified on the drawings.

2. Ground all grounding type receptacles to the outlet boxes with a No. 12 THWN-2/THHW/MTW/XHHW-2 green conductor connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.

3. Ground medium voltage power cable metallic shielding at each end of the cable and at each splice. Maintain shield continuity around splices.

4. Single-point ground instrumentation cable shields at the signal ground bus at the control panel end of the circuit.

5. Mechanically connect grounding electrode conductors to the foundation reinforcing steel where shown on the drawings.

6. Seal exposed connections between different metals with electrical joint inhibitor compound. Clean and coat all buried connections with electrical joint inhibitor compound before backfilling.

C. Grounding wires

1. Unless otherwise specified, provide continuous, unspliced equipment grounding conductors.

2. Lay all underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other mechanical guards. If guards

are steel pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified in this Section.

3. Where grounding conductors extend beyond the perimeter of the building to site structures, the grounding electrode system shall be continuous and the grounding conductor shall be encased in concrete ductbanks.

D. Fasteners

1. Clean the connector and conductor surfaces with a wire brush or emery cloth to a shiny, bright surface. For plated surfaces, use compatible solvent cleaning in order not to remove any portion of the plating.

2. Apply electrical joint inhibitor compound immediately after cleaning.

3. All fasteners shall engage a minimum of four full threads for electrical connections and equipment mounting.

4. Coat all bolts with electrical joint inhibitor compound.

5. Torque fasteners to NETA specifications.

E. Safety

1. Reference Section 01 35 44 Environmental Requirements prior to commencing work related to hazardous materials.

F. Wire identification

1. Tag and lace all wires in test stations, pull or junction boxes, vaults, at each termination. Wire identification text shall be as shown on the drawing. Reference Section 26 05 53 for identification products.

3.2 INSPECTION AND TESTING

A. Inspect the grounding and bonding system conductors and connections for tightness, proper installation, and proper application of electrical joint inhibitor compound.

B. Electrical continuity of the pipe system shall be tested.

C. Perform resistance to ground testing during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

D. Perform testing before energizing the distribution system.

E. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms or if the resistance to ground for a substation is greater than one ohm.

F. Refer to Section 26 08 00 for additional test requirements.

1. NOT USED.

2. The testing firm shall prepare a system energization report. The system energization report shall include the results of the testing and all other data pertinent to the performance of the grounding system, including deficiencies.

3. Report any deficiencies of systems tested to the District. The Contractor shall be responsible for repairs to the systems, at no additional cost to the District. Any retesting required shall be paid for by the Contractor, including additional District costs for witnessing additional testing. Once all deficiencies have been corrected, the Contractor shall submit a final version of the energization report.

END OF SECTION

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Conduit support systems.

B. Instrument racks shall be provided as shown on the Drawings.

C. Conduit racks shall be provided as shown on the Drawings.

1.2 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

1. Shop Drawings

a. Submit complete conduit layout Drawings for each conduit system. Indicate the type and locations of hangers, supports, anchors, guides, anchor bolts, and any other conduit supporting appurtenances.

b. Where standard hangers and/or supports are not suitable, submit detailed Drawings showing materials and methods of construction for each type of custom hanger and support.

c. Submit detailed Drawings any construction-related deviations in conduit layouts, materials or routing. The review of construction-related deviation submittals shall only be for conformance to the Specifications and Drawings.

2. Product Data

a. Submit catalog cuts, Specifications and dimensioned Drawings for each type of conduit hanger and support.

b. Indicate materials of construction, important dimensions and range of conduit sizes for which each hanger is suitable.

c. Submit detailed information on anchor bolts, hardware, anti-seize compounds, and any other appurtenant materials.

d. The product data shall include a representative catalog cut for each different type of conduit hanger or support indicating the materials

of construction, important dimensions and range of conduit sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and methods of construction for each type of special hanger and/or support.

e. Include design calculations of support reactions transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances including structural fasteners.

B. Certifications

1. Submit design calculations and drawings for all conduit support systems stamped by an independent licensed Professional Engineer in the State of California who is engaged in the business of conduit support system analysis and design. Conduit support design engineer shall certify that the conduit support design meets the specified project site and loading requirements and the design is in accordance with all applicable codes specified herein and in Division 01.

a. Independent conduit support design Engineer shall submit experience record in design and fabrication of conduit hangers and supports as specified herein. The support design Engineer shall have not less than 3 years of experience within the last 5 years in the analysis and design of conduit support design.

2. Stamped calculations shall not be required prior to installation. All layout and support detail submittals shall bear the stamp of the independent licensed professional engineer.

3. Stamped "Record" drawings and calculations shall be submitted after final installation for Project Records.

C. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As listed in the remainder of this Section.

B. Fasteners and supports as manufactured by Caddy are not acceptable.

2.2 CONDUIT

A. Single Conduit:

1. Support from beam flange:

    a. Beam Clamp:

        1) Appleton #BH500 for conduit 1” and smaller

        2) Appleton #BH502 for conduit 1-1/4” and larger

    b. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

2. Support: Machine screw between clamp and hanger.

    a. Beam Clamp:

        1) Appleton #BH500 for conduit 1” and smaller

        2) Appleton #BH502 for conduit 1-1/4” and larger

    b. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

    c. Threaded Rod: Zinc-plated or galvanized steel, threaded, Minerallac.

        1) 1/4” diameter for conduit 1” and smaller

        2) 3/8” diameter for conduit 1-1/4” and larger

    d. Support:

        1) Nut on rod on both the inside and outside of the clamp; outside nut to act as locking nut

        2) Nut on rod on inside of hanger

3. Supported from concrete slab or roof

    a. Support: One-hole strap, Minerallac MIN-E snap-on clip.

    b. Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.

4. Supported and suspended from concrete slab or roof:

    a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

    b. Threaded Rod: Zinc-plated or galvanized steel, threaded, Minerallac.

1) ¼" diameter for conduit 1" and smaller

2) 3/8" diameter for conduit 1-1/4" and larger

c. Support:

1) Nut on rod inside and outside of hanger

2) Nut on rod on inside of hanger

d. Concrete Insert: Phillips Redhead, 'J' or 'S' Series.

5. Supported from metal deck:

a. Support: One-hole strap, Minerallac MIN-E snap-on clip.

b. Concrete Insert: Phillips Redhead, 'J' or 'S' Series.

6. Supported and suspended from metal deck:

a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

b. Threaded Rod: Zinc-plated or galvanized steel, threaded, Minerallac.

1) ¼" diameter for conduit 1" and smaller

2) 3/8" diameter for conduit 1-1/4" and larger

c. Support:

1) Nut on rod inside and outside of hanger

d. Anchor in deck: Fender washer with nut.

7. Supported from gypboard, concrete or hollow masonry wall:

a. Conduit Hanger: Two-hole heavy-duty strap, Minerallac 200 Series.

b. Anchor:

1) Gypboard: Toggle bolt.

2) Concrete: Phillips Redhead, 'J' or 'S' Series.

3) Masonry Wall: Molly bolt.

8. Supported from damp or outside concrete wall:

    a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

        1) Anchor: Phillips Redhead, ‘J’ or ‘S’ Series.

B. Multiple Conduits:

1. Supported from concrete slab or roof:

    a. Support: One-hole strap, Minerallac: MIN-E snap on clip.

    b. Concrete: Phillips Redhead, ‘J’ or ‘S’ Series.

2. Supported and suspended from concrete slab or roof:

    a. Conduit Hanger: Unistrut pipe clamp #P1100 Series for rigid and #P1200 Series for EMT.

    b. Threaded Rods (2 required): 3/8” diameter.

    c. Support:

        1) Unistrut #P-1000, length as required.

    d. Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.

3. Supported from metal deck:

    a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac #O-B through 10-B as required.

    b. Anchor in Deck: Fender washer with nut.

4. Supported and suspended from metal deck:

    a. Conduit Hanger: Unistrut pipe clamp #P1100 Series for rigid and #P1200 Series for EMT.

    b. Threaded Rods (2 required): 3/8” diameter.

    c. Support:

        1) Unistrut #P-1000, length as required.

        2) Nut on rod on outside of unistrut and unistrut spring-loaded nut on inside of unistrut

d. Anchor in Deck: Fender washer with nut.

5. Supported from gypboard, concrete or hollow masonry wall:

a. Conduit Hanger: Unistrut pipe clamp #P1100 Series for rigid and #P1200 Series for EMT.

b. Support:

1) Unistrut #P-1000, length as required.

c. Anchor:

1) Gypboard: Toggle bolt.

2) Concrete: Phillips Redhead, 'J' or 'S' Series.

3) Masonry Wall: Molly bolt.

2.3 SLEEVES

A. Rigid galvanized steel conduit for conduit penetrations through rated walls and floors.

B. Conduit sleeve shall be a minimum of 1" larger in diameter than penetrating conduit.

PART 3 - EXECUTION

3.1 CONDUIT SUPPORTS

A. Securing and supporting of conduit shall be in accordance to NEC 344.30(A) and (B).

B. Support Horizontal Conduit as follows:

Nominal Conduit Size (inches)	Max. Distance Between Support (feet)
¾	10
1	12
1 ¼	14
1 ½	14
2	16
2 ½	16
3	20
3 ½	10
4	20
4 ½	20

5	20
6	20

C. Rigid galvanized steel shall be supported within 3’ of every outlet box, junction box, cabinet, or fitting. Flexible shall be conduit 1”.

D. Support vertical conduit at every floor with a maximum of 10’ between supports.

E. Liquid tight flexible non-metallic conduit shall be supported in accordance to NEC 356.30 and as follows:

1. In lengths longer than 6 feet, the conduit shall be securely fastened at intervals not exceeding 3 feet and within 12 inches on each side of every outlet box, junction box, cabinet, or fittings.

2. Securing and supporting of the conduit is not required for lengths of 3 feet or less when connecting to field equipment (examples motor, instrumentation, etc.).

3.2 SLEEVES

A. Provide conduit sleeves for every fire-rated wall or floor where conduit penetrates.

3.3 ANCHORS

A. Anchors shall be installed using the proper drill bits and power tools.

B. Anchors shall be installed per manufacturer’s recommendations.

3.4 QUALITY ASSURANCE

A. All products shall be used as designed and for their intended purpose. Alterations, e.g. bent threaded rod as a u-bolt, shall not be allowed. Necessary support modifications due to project site constraints shall be directed to the Engineer.

END OF SECTION

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section covers the work necessary to furnish and install complete raceways and boxes for electrical systems.

B. Related sections:

1. Section 01 33 00 – Submittal Procedures
2. Section 01 33 12 – Seismic Design Criteria
3. Section 09 90 00 – Painting and Coating
4. Section 26 05 00 – Common Work Results for Electrical
5. Section 26 05 26 – Grounding and Bonding for Electrical Systems
6. Section 26 05 29 - Hanger and Supports for Electrical Systems
7. Section 26 05 53 – Identification for Electrical Systems
8. Section 26 08 00 – Commissioning of Electrical Systems

C. Related work specified elsewhere:

1. All concrete shall be as specified in Division 03, but the responsibility of furnishing and installing the materials shall be that of this Section.
2. For trapeze and conduit supports using hangers, refer to Section 26 05 29 Hanger and Supports for Electrical Systems.

1.2 REFERENCES

A. California Code of Regulations

1. Title 24, Part 3 – California Electrical Code (CEC)

1.3 QUALITY ASSURANCE

A. Seismic design requirements for conduit hangers and supports:

1. All raceway systems to be furnished under this Section shall be designed and constructed to meet the seismic requirements of Section 01 33 12.

B. The Contractor shall require that all persons engaged in the installation of PVC coated rigid galvanized steel conduit, elbows, nipples, and fittings attend installation training classes given by the approved manufacturer at the job site before any conduit installation work begins. The classes shall be carried out by technically competent and experienced instructors who are certified manufacturer's employees and instructors acceptable to the Engineer. Installers must be able to show a valid, unexpired Installer Certification card.

C. The Contractor shall demonstrate to the Engineer that the approved manufacturer's recommended installation tools and methods are being utilized on the job site by all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings. These tools and methods shall include, but not be limited to, clamp inserts for use on power driven units of chain vises, new die heads and enlarged pipe guides in conduit threading machines, and strap wrenches and extra wide wrench jaws for use in conduit assembly.

1.4 SUBMITTALS

A. Make submittals in accordance with Section 01 33 00 Submittal Procedures, and Section 26 05 00 Common Work Results for Electrical.

PART 2 - PRODUCTS

2.1 GENERAL

A. Rigid Steel Conduit

1. Hot-dipped galvanized rigid steel conduit, including threaded type couplings, elbows, nipples, and other fittings, shall meet the requirements of ANSI C80.1, ANSI C80.4, UL and the CEC. Do not use setscrew or threadless type couplings, bushings, elbows, nipples, and other fittings, except when approved in writing by the Engineer.

2. Acceptable manufacturers:

a. Allied Tube and Conduit

b. Western Tube and Conduit

c. Or equal.

B. PVC-coated rigid steel conduit

1. PVC-coated rigid steel conduit shall be hot-dipped galvanized rigid steel conduit meeting the requirements of NEMA RN 1, ETL PVC-001, UL 6, ANSI C80.1 and the CEC, and a factory installed PVC coating 40 mils nominal thickness, and applied over and permanently bonded to the galvanized surface, with an interior 2 mil urethane coating. All male threads on conduit, elbows, and nipples shall be hot galvanized and protected by an application of a urethane coating. Couplings, elbows, nipples and other fittings shall be threaded and galvanized and shall have integral plastic sleeves which overlap the plastic-coated conduit with pressure sealing sleeves. Use PVC coated conduit suitable for conductors with 75 degrees C insulation.

2. Acceptable manufacturers:

a. Robroy; Plasti-Bond RedH_2OT

b. Perma-Cote

c. Or equal.

C. Flexible Metal Conduit, Liquid-Tight

1. Flexible metal conduit shall be UL listed, liquid-tight, consisting of galvanized steel flexible conduit covered with an extruded gray PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

2. Acceptable manufacturers:

a. Anaconda Sealtite Type UA

b. Electri-Flex Liquatite Type LA

c. Or equal.

D. Pulling Tape – pulling conductors into conduits

1. Flat, woven, polyester tape used for installing fiber optic, copper, and coaxial cables in underground conduit. Tape shall have the following characteristics:

a. Lubricated for easy installation and reduced friction.

b. Printed with sequential footage markings.

c. 2,500 pound tensile strengths.

2. Acceptable manufacturers:

a. NEPTCO, Polyester MULETAPE.

b. Or equal.

E. Pulling Tape – Empty spare conduits

1. Flat, woven, polyester tape with insulated 22 gauge metallic conductor to enable detection of empty, spare conduits. Tape shall have the following characteristics:

a. Lubricated for easy installation and reduced friction.

b. Printed with sequential footage markings.

c. 2,500 pound tensile strengths.

2. Acceptable manufacturers:

a. NEPTCO, Detectable MULETAPE, DT Series.

b. Or equal.

F. Raceway Fittings

1. Fittings for Rigid Steel:

a. Watertight hubs for rigid steel conduit shall be male thread type zinc-plated malleable iron with recessed "O" ring seal, insulated throat, and locking screw.

1) Acceptable manufacturers:

a) OZ Gedney, Type CHM-T

b) Cooper Crouse-Hinds, Raintight Malleable Iron “MHUB”

c) Or equal.

b. Provide all malleable iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets.

1) Acceptable manufacturers:

a) Appleton, Form 35 Threaded Unilets

b) Killark, Duraloy 5 Series Malleable Iron

c) Or equal.

2. Fittings for Liquid-Tight Flexible Metal Conduit:

a. Straight, 45 degree angle, or 90 degree angle connectors with malleable iron gland nut, polyethylene compression ring, steel ferrule, malleable iron conduit assembly with insulated throat, steel lock nut, and copper grounding lug.

1) Acceptable manufacturers:

a) Cooper Crouse-Hinds, Liquidator Series

b) Steel Electric Products

c) Or equal.

3. Fittings for PVC-Coated Rigid Steel Conduit:

a. Watertight and corrosion resistant hubs for PVC Coated Rigid Steel conduit shall have a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves.

1) Acceptable Manufacturers:

a) Robroy Plasti-Bond Red Type ST Hub

b) Perma-Cote Industries Supreme Type ST Hub

c) Or equal.

b. For corrosion resistant conduit bodies for use with PVC Coated Rigid Steel conduit sized as required by the CEC, use cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating and nominal 2 mil internal urethane coating, and pressure sealing sleeves on all conduit openings.

1) Acceptable manufacturers:

a) Robroy Plasti-Bond Red Conduit Bodies

b) Perma-Cote Industries Supreme Conduit Bodies

c) Or equal.

c. In NEMA 4X areas, provide zinc-plated malleable iron or galvanized steel insulated throat connectors for liquid-tight flexible metal conduit, suitable for use in wet locations, with a minimum of 40 mil PVC exterior coating and pressure sealing sleeves.

1) Acceptable manufacturers:

a) Robroy Plasti-Bond Red Liquid Tight Connectors

b) Perma-Cote Industries Supreme Liquidtight Connectors

c) Or equal.

G. Expansion/Deflection Couplings

1. Provide expansion/deflection couplings for use where shown on the drawings and wherever conduit crosses an expansion joint. The couplings shall alleviate longitudinal, angular, and shear conduit stress caused by differential settlement.

2. Acceptable manufacturers:

a. Appleton/O-Z Gedney Type DX

b. Cooper/Crouse-Hinds Type XD

c. Or equal.

H. Expansion Couplings

1. Provide expansion couplings for use where shown on the drawings. The couplings shall allow for expansion and contraction up to a maximum of 8” (4” in either direction) in a run of rigid metal conduit.

2. Acceptable Manufacturers:

a. Appleton/O-Z Gedney Type AX-8

b. Cooper/Crouse-Hinds Type XJG

c. Or equal.

I. Supports and Fittings

1. For areas not designated as NEMA 4X on the drawings, supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet seismic requirements. Finish shall be hot-dipped galvanized steel for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-bolts, beam clamps, and other supports and fittings.

   a. Acceptable manufacturers:

      1) Unistrut, B-Line

      2) Power Strut

      3) Or equal.

2. For equipment required to be NEMA 4X stainless steel or as noted on the Drawings; supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet seismic requirements. Materials of construction shall be SS316, 40 mil PVC coated hot-dipped stainless steel, or self-extinguishing fiberglass which meets UL-94V-0 flammability tests, for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-bolts, beam clamps, and other supports and fittings.

   a. Acceptable Manufacturers:

      1) Robroy Plastibond-Red PVC Coated Steel Strut and accessories

      2) Perma-Cote Supreme PVC Coated Steel Channel and accessories

      3) Or equal.

J. Wireways

1. For equipment required to be rated as NEMA 1 or NEMA 12 or as noted on the Drawings, provide UL listed, hinged cover, NEMA 12 wireway bodies and covers fabricated from 16 gauge steel minimum, with an enamel or epoxy finish.

   a. Acceptable Manufacturers:

      1) Square D Square-Duct Wireway

2) Hoffman

3) Or equal.

2. For all other areas or where NEMA 3R, NEMA 4, or NEMA 4X is required or as shown on the drawings, provide UL listed, raintight, hinged cover NEMA 4X wireway bodies and covers fabricated from stainless steel.

a. Acceptable Manufacturers:

1) Square D

2) Hoffman

3) Or equal.

K. Boxes and Fittings

1. Pressed steel switch and outlet boxes shall be hot-dipped galvanized.

a. Acceptable Manufacturers:

1) Raco Manufacturing Co

2) O.Z. Manufacturing Co

3) Or equal.

2. Type NEMA 1 terminal boxes, junction boxes, pull boxes etc. shall be sheet steel unless otherwise shown on the drawings. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 14 gauge metal. Boxes shall have continuous welded seams and shall be used for dry, non-process indoor locations shown on the drawings. Furnish terminal boxes with hinged doors, terminal mounting straps, and brackets. Terminal blocks shall be NEMA type not less than 30A, 600V.

a. Acceptable Manufacturers:

1) Hammond Manufacturing

2) Weigmann

3) Or equal.

3. Type NEMA 12 terminal boxes, junction boxes, pull boxes, etc., shall be sheet steel unless otherwise shown on the drawings. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground

smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 14 gauge metal. Covers shall be gasketed with rolled lip and fastened with stainless steel clamps. Furnish boxes with continuous hinged doors, terminal mounting straps, and brackets. Terminal blocks shall be NEMA type, not less than 30A, 600V.

a. Acceptable Manufacturers:

1) Hammond Manufacturing

2) Weigmann

3) Or equal.

4. Type NEMA 4X locations (outdoors or as required), terminal boxes, junction boxes, pull boxes etc., shall be Type 316L stainless steel (NEMA 4X locations) unless otherwise shown on the drawings. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Furnish terminal boxes with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 30A, 600V.

a. Acceptable Manufacturers:

1) Hammond Manufacturing

2) Weigmann

3) Or equal.

5. All boxes and fittings used with PVC coated conduit shall be furnished with a PVC coating bonded to the metal, the same thickness as used on the coated steel conduit. The ends of couplings and fittings shall have a minimum of one pipe diameter PVC overlap to cover threads and provide a seal.

6. Device boxes shall be malleable iron with zinc electroplate and epoxy powder coat finish, malleable iron covers, and stainless steel screws. Provide the “deep” configuration for all devices boxes.

a. Acceptable Manufacturers:

1) Appleton, UNILETS Malleable Iron, Type FD

2) Steel Electric Products, Type FD

3) Or equal.

L. Conduit Penetration Seals and Sleeves

1. Conduit penetration seals shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the opening. The elastomeric element shall be sized and selected per the manufacturer's recommendations and shall be suitable for use in standard service applications (-40 degree F to 250 degrees F).

2. Sleeves shall be the thermoplastic type with water stops, suitable for poured wall construction.

3. Conduit penetration seals and sleeves shall be complete assemblies supplied by a single manufacturer.

4. Acceptable manufacturers:

1) Thunderline Corporation Link-Seal and Plastic Sleeves

2) Calpico Inc. Pipe Linx and Plastic Sleeves

3) Or equal.

M. Duct Seal for used with conduit in Non-Classified Areas and Non-Classified conduits and fittings.

1. Duct seal shall be a non-hardening compound designed as a waterstop and moisture barrier for sealing the annular space between conduit and electrical conductors and cables. Duct seal shall be adhered to conduit annular space and shall not adversely affect metal, PVC, polyethylene or rubber. Duct seal shall be paintable.

2. Acceptable manufacturers:

a. Ideal Industries Inc. , P/N 31-601

b. O-Z Gedney DUX

c. Thomas & Betts, Type DX

d. Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Check the approximate locations of raceway system components shown on drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer. Make modifications and changes required.

B. Protection during construction:

1. In addition to the requirements of Division 01, and Section 26 05 00, prior to installation, store all products in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction. Cover PVC conduit, elbows, and PVC coated rigid steel conduit, nipples, elbows, and fittings from exposure to sunlight.

C. Material and equipment installation:

1. Follow manufacturer's installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturer's installation instructions, codes and regulations, and these contract documents, follow Engineer's decision. Keep copy of manufacturer's installation instructions on the jobsite available for review at all times.

3.2 INSTALLATION

A. Use no circular raceway less than 3/4-inch unless otherwise approved by the Engineer.

B. Raceway type for location and installation method unless noted otherwise on the drawings.

1. Exterior, Exposed (higher than 6-inches above grade), all locations except those designated as NEMA 4X or NEMA 6P:

a. PVC coated rigid steel conduit.

2. Interior, Exposed or Concealed (Not Embedded in Concrete), all locations except those designated as NEMA 4X or NEMA 6P:

a. Rigid steel conduit.

3. Risers from concealed nonmetallic conduit, floor stub-ups, wall, or ceiling penetrations; also, all locations designated NEMA 4X or NEMA 6P:

a. PVC coated rigid steel conduit.

4. Direct buried

a. PVC Coated Rigid Steel Conduit.

C. Location, Routing, and Grouping:

1. Conceal or expose raceways as indicated on the drawings. Group raceways in same area together. Locate raceways at least 12 inches away from parallel runs of heated piping for other utility systems.

2. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible.

3. Avoid obstruction of passageways. Run concealed raceways with the minimum of bends in the shortest practical distance considering the building construction and other systems.

4. In outdoor, underground, or wet locations, use watertight couplings and connections in raceways. Install and equip boxes and fittings so as to prevent water from entering the raceway.

5. Paint all threads of galvanized conduits with zinc-rich paint or liquid galvanizing compound before assembling. Touch up after assembly to cover nicks or scars.

6. Do not notch or penetrate structural members for passage of raceways except with prior approval of the Engineer.

7. Do not run raceways horizontally in equipment foundation pads.

8. Separate raceway in slabs not less than three times the largest raceway outside diameter minimum, except at raceway crossings, and then only with the approval of the Engineer.

9. Do not run raceways across walkways.

10. Pull boxes, junction boxes, and/or handholes shall be used in any conduit. Pull boxes shall be provided every 200 feet of straight run, every 150 feet with 90 degrees of bends, every 100 feet with 180 degrees of bends, and every 50 feet with 270 degrees of bends.

11. Conduits must be kept within the furring lines of building walls and ceilings unless specifically noted to be exposed.

12. Provide all necessary sleeves and chases required where conduits pass through floors or walls; seal all openings and finish to match adjacent surfaces.

13. Where conduit runs change from concrete embedded within floors, slabs, or equipment pads to exposed, maintain a minimum separation of 6-inches between the closest wall, pad, or structure face and the outer edge of the exposed conduit.

D. Special Locations:

1. Where conduit changes from underground direct burial to exposed, extend PVC coated rigid steel conduit minimum 6-inches above finished grade.

2. Final Connection to Equipment:

a. In area's not classified as Class 1, Division 1 or Division 2 make final connection to motors, wall or ceiling mounted fans and unit heaters, dry type transformers, valves, local instrumentation, and other equipment where flexible connection is required to facilitate removal or adjustment of equipment with 18-inch minimum, 60-inch maximum lengths unless otherwise approved by the Engineer, of liquid-tight, PVC-jacketed flexible metal conduit where the required conduit size is 4 inches or less. For larger sizes, use rigid steel conduit as specified.

b. The flexible conduit shall be long enough to allow the item to which is connected to be withdrawn or moved off its base. Use liquid-tight flexible metal conduit in outside areas, process areas exposed to moisture, and areas required to be oil-tight and dust-tight.

E. Support:

1. Support raceways at intervals not exceeding CEC requirements unless otherwise indicated. Support multiple raceways adjacent to each other by ceiling trapeze. Support individual raceways by wall brackets, strap hangers, or ceiling trapeze, fastened by toggle bolts on hollow masonry units, expansion shields on concrete or brick, and machine screws or welded thread studs on steelwork.

2. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion shields.

3. Support all raceways from structural members only. Do not support from pipe hangers or rods, cable tray, or other conduit.

4. Do not use nails anywhere or wooden plugs inserted in concrete or masonry as a base for raceway or box fastenings. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

5. Support flexible conduit with conduit clamps, except where the flexible conduit is fished and where sections less than 4 feet in length are used in concealed areas to supply lighting fixtures in accordance with the CEC.

F. Bends:

1. Make changes in direction of runs with symmetrical bends or cast metal fittings. Make bends and offsets of the longest practical radius. Avoid field-made bends and offsets where possible, but where necessary, make with an acceptable hickey or conduit bending machine. Do not heat metal raceways to facilitate bending.

2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel and of neat appearance. Factory elbows may be used in parallel or banked raceways if there is a change in the plane of the run and the raceways are of the same size. Otherwise, make field bends in parallel runs.

3. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduits flexibility.

G. Threaded Joints:

1. Paint all field-cut threads with zinc rich paint or liquid galvanizing compound for rigid steel conduit after removal of chips and cleaning with solvent and use manufacturer approved thread compound for PVC-coated rigid steel conduit. Use approved, highly conductive jointing compound on all joints

a. Approved Manufacturers:

1) Appleton Type TLC

2) Or equal.

H. Bushing and Insulating Sleeves:

1. Where rigid steel conduit, PVC coated rigid steel conduit, or liquid-tight flexible metal conduit enters metal enclosures, install an insulated throat grounding bushing on the end of each conduit. Install a bonding jumper from the bushing to any equipment ground bus or ground pad.

Interconnection of bonding jumpers from each conduit grounding bushing to the equipment ground bus or ground pad is acceptable.

2. If neither a ground bus or ground pad exists, connect the bonding jumper to the metallic enclosure with a bolted-lug connection.

3. Make conduit connections to NEMA 3R, NEMA 4, or NEMA 4X enclosures, junction boxes, terminal junction boxes, or device outlet boxes with watertight, corrosion resistant hubs. The conduit connections shall maintain the integrity of the enclosure NEMA rating.

I. PVC Coated Rigid Steel Conduit:

1. Install in strict accordance with the manufacturer's instructions. Touch up any damage to the coating with conduit manufacturer touch-up compound. PVC boot shall cover all threads. Where belled conduits are used, bevel the unbelled end of the joint before joining. Leave no metallic threads uncovered. Clean field threads with solvent and coat with urethane touch-up. Keep two cans of urethane touch-up at each threading station.

J. Penetrations:

1. Seal the interior of all raceways entering structures or buildings at the first box or outlet with duct seal to prevent the entrance into or exit from the structure of gases, liquids, or rodents.

2. Where conduit enters an existing structure above ground or below grade through a concrete roof or wall, core drill through the existing roof or wall and install a watertight conduit penetration seal. Install the sealing assembly such that it may be tightened at any time from the interior side. Dry pack with non-shrink grout around the conduit and the sealing assembly on the exterior side.

3. All connections between conduits and NEMA 1, 1A, and 12 enclosures shall be made with hubs outside and bushings on the inside. All NEMA 3R, 4, and 4X enclosures without integral watertight hubs shall have watertight, threaded, rigid, conduit hubs.

4. Perform non-destructive scanning on all walls, floor, and ceiling penetrations prior to core drill.

K. Wireways

1. Mount wireways securely in accordance with the CEC and manufacturer's instructions. Locate removable cover on accessible vertical face of wireway unless otherwise indicated.

L. Preparation for Pulling in Conductors

1. Do not install crushed or deformed raceways. Avoid traps in raceways. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull tape.

2. For underground concrete-encased and direct-buried raceways, prove the integrity of the raceway system as specified in Section 26 05 43 before pulling in conductors.

3. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

M. Empty Raceways

1. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty raceway. Provide a removable cap over each end of empty raceways. Provide a detectable pull tape with a minimum of 3-feet of slack at each end in each empty raceway. Provide cap with eyelet for attaching the pull tape.

2. Strip insulation from the jacket of the detectable pull tape wire and attach to the ground rod in each manhole or pullbox, to the frame of metallic pullboxes, to switchgear ground busses, to switchboard ground busses, and to control panel ground busses.

3.3 PAINTING

A. Paint exposed metal raceway systems in finished areas in accordance with the requirements in Section 09 90 00.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. All electrical equipment and systems shall include identification tags or nameplates as shown on the drawings and as specified herein.

2. The Contractor shall develop a tagging system in accordance with the conduit and cable schedules or as shown on the drawing and submit same to the Engineer for review and approval before proceeding.

   a. In the event of conflicts with other Specification Sections or the Plans, the more conservative requirement shall take precedence.

B. Related Sections:

1. Section 01 33 00 – Submittal Procedures

2. Section 10 14 00 – Signage

3. Section 26 05 00 – Common Work Results for Electrical

4. Section 26 08 00 – Commissioning of Electrical Systems

1.2 SUBMITTALS SHALL BE MADE IN ACCORDANCE WITH SECTION 01 33 00

A. In addition to the requirements of Section 01 33 00:

1. Submit proposed identification system products including catalog data sheets and literature applicable to the requirements of this Section.

2. A tagging system scheme or schedule shall be submitted to the Engineer for review and approval prior to tagging of equipment.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Conduit Identification Tags

1. Provide permanent, pressure stamped SS316 round tags with conduit numbers as designated on the conduit schedule drawings. Tags relying on adhesives or taped-on markers are not acceptable.

2. Tag Construction: Tags shall be stamped stainless steel Type 316 round tags with 2" diameter minimum, 0.037" thickness minimum, and a 3/16" hole diameter.

3. Tag Attachment:

   a. Hanger: Tag fasteners shall be plastic coated, flexible, multi-stranded 18-8 stainless steel cable. Cable shall be 7x7 strand core 0.036" cable diameter minimum with 0.044" coating diameter. Nylon ties are not acceptable. Clamps shall be stainless steel crimped clamping sleeves.

      1) Acceptable cable products: McMaster-Carr 8930T28, or equal.

      2) Acceptable clamping sleeve products: Brady 38090, McMaster-Carr 3755T11, or equal.

4. Provide "Caution Fiber Optic Cable" labels where fiber optic conduits are shown on the drawings.

B. Cable Identification Tags

1. Wire tags relying on adhesives or taped-on markers are not acceptable.

2. Provide white heat-shrinkable polyolefin sleeve wire tags with legible machine printed weatherproof black marking. Wire tag shall be glossy finish, minimum 0.020 inch wall thickness, and 2 inch width minimum.

3. Wire tag diameters shall be appropriate for the required lines of text and/or wire size. Wire tag diameters used shall be consistent amongst wires of similar signal types.

4. Performance temperature -40°F to 212°F, humidity resistance 95% R.H. and UV resistance.

5. Meet UL Standard 224 for flammability.

6. Provide necessary tools and accessories to print labels and shrink labels.

7. Acceptable Manufacturers:

   a. Brady, B33 Series B-342 PermaSleeve Marker, Model B33-125-2-342, B33-250-2-342.

b. Panduit, Permanent Sleeve, Model H200X025H1T, H200X044H1T.

c. Or equal.

C. Equipment Nameplates

1. The legend plates or nameplates shall be a minimum of 1/2” inches high and 2 – 1/2 inches wide and shall be attached to the equipment by means epoxy adhesive. The plates shall be approximately 3/22-inch thick with beveled edges and shall have letter sizes and legends as accepted by the Engineer.

2. Plates shall be made of laminated phenolic material with a black surface layer and white base material beneath. Engraved letters shall be l/4-inch high extending through the black face into the white layer resulting in white letters on black background.

   Where nameplates cannot be mounted on the equipment, attach the nameplate or tag with a stainless steel cable.

3. Acceptable Manufacturers:

   a. Brady

   b. Seton

   c. Or equal.

D. Pushbutton Legend Plates

1. Provide legend plates for pushbuttons, selector switches, pilot lights, and process displays with inscription as shown on the drawings. Provide adapter ring as necessary to fit devices with legend plates. Legend plates shall be made by same manufacturer as pushbutton device, selector switch and pilot light.

2. Acceptable Manufacturers:

   a. Cutler-Hammer HT800 Series

   b. Allen Bradley Bulletin 800T

   c. Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Cable numbers

1. Label cables with cable numbers as shown on drawings.

2. Identify cables in all accessible locations such as manholes, handholes, control panels, panelboards, pull boxes, junction boxes, wireways, junction terminal boxes, switchgear, motor starters, disconnect switches, etc. For identification, use cable tags specified herein.

3. Install cable numbers at maximum 100 feet intervals for cables on cable tray or plenum space.

B. Conductor Identification:

1. Identification system shall use the format as described under paragraph 3.2.

2. Identify cables terminations in equipment such as control panels, panelboards, junction terminal boxes, switchgear, motor starters, disconnect switches, etc. For identification, use cable tags specified herein.

C. Conduit numbers

1. Label conduits with conduit numbers as shown on drawings.

2. Attach conduit tags at each end of conduit run. Attach tags to conduits at least once every 50 feet of exposed conduit in ceiling spaces and on surface mounted conduits. For identification, use conduit tags specified herein.

D. Nameplates

1. Nameplates shall be permanently attached to the device specified and located on the device so as to be easily read under normal operation of the device. Nameplates shall not alter nor limit the rating, function, UL listing, and enclosure NEMA rating of the device. Nameplates shall be smoothly attached to the device with no overlaps, protrusions, or sharp edges and corners.

2. Nameplates shall be installed on the doors or covers of all panels, panelboards, starters, contactors, relays and all other electrical equipment enclosures furnished under this Contract and as indicated on the drawings.

3. Nameplates shall be engraved with inscriptions as shown on the drawings; if not shown, Contractor shall submit a schedule showing what is shown as well as what is proposed for the Engineer's approval.

4. Each device which indicates the operation of the equipment, or which may be operated to affect the equipment, shall have an integral legend plate or nameplate indicating the device function. These shall be inscribed as indicated on the drawings or as approved by the Engineer.

E. Raceways

1. Contractor shall assign conduit and cable numbers in accordance with the following system where raceway numbers have not been assigned

Raceway Prefix	Type of Function
C	Control or power - 120V or less
N	Pneumatic tubing
P	Power 120V to 600V
S	Signal - data communication or instrumentation

Prefixes shall be followed by a 3 to 4 digit number. Add a letter suffix to distinguish the raceway to designate a sub-branch from the main raceway.

Example:

Raceway number = P109A where:

P = conduit contains power
109 = unique 3-digit number
A = letter to distinguish raceway feed off from the raceway #109

3.2 TAGGING OF WIRES AND CABLES

A. All wires and cables shall be neatly bundled, tagged, and laced in pull or junction boxes, manholes, handholes, wireways, and at each termination. Each bundle of wire and cable shall be tagged at least once as it passes through each pull or junction box, manhole, handhole, and at each termination. Each bundled wire and cable shall be tagged at least once as it passes through wireways. Wires and cables shall be laced into groups representing each individual circuit, and each group or cable shall be tagged with the corresponding circuit number or cable number. Power, lighting, control, alarm, annunciator, and instrumentation wiring shall be bundled, laced, and tagged, as specified herein.

B. Tags for use in pullboxes, handholes, and manholes shall be made of minimum 1/8- inch-thick black laminated plastic, 1-1/2-inch by 3-1/2-inches, with white

engraved identification in letters 3/64-inch deep by 3/16-inch high minimum. Tags shall be drilled at each end and secured twice to each cable or laced-together with plastic tie wire or other method approved by the Engineer.

C. All wires and cables within control panels, switchgear, motor control centers, mechanical mounting panels, terminal junction boxes, etc., shall be tagged at each termination with conductor tags as specified. All circuit identification tags shall be readily accessible for inspection at the locations cited above.

D. Label wires with cable numbers as shown on the drawings. Cable labels shall be placed within one inch of the ends of the cable jacket.

E. All spare pairs shall be bundled and labeled with the cable designation. All individual pairs shall be tagged to enable identification of spare pairs when making future terminations.

F. Identify multi-circuit control cables and individual instrumentation and control circuits as indicated on the drawings. Multi-circuit cable shall be tagged with the cable name around the entire cable assembly and shall have the individual circuits tagged as well. Tag twisted, shielded pairs and where exposed, multi-pair cable twisted pairs around each pair separately.

G. Identify each individual conductor at each termination. This includes such locations as switchgear, switchboards, motor control centers, variable frequency drives, control panels, junction/terminal boxes, all field devices, security panels and junction boxes, and all other locations where conductors are terminated. Identify the termination of these conductors in accordance with the accepted shop drawings. Tag conductors with sleeve type labels.

H. Where more than 1 nominal voltage system exists, identify each ungrounded system conductor by phase and system. Permanently post means of identification at each branch-circuit panelboard, switchboard, switchgear, motor control center, or other type of power distribution equipment.

I. Include the following minimum information for wire and cable identification:

1. Circuit number or load identification tag number.

2. Origin (from source)

3. Destination (to load)

J. Wire Numbers:

1. The Contractor shall coordinate the wire numbering system with all vendors of equipment so that each and every field wire has a unique wire number associated with it for the entire system.

a. Wire numbers shall correspond to the wire numbers on the control drawings, or panel and circuit numbers for receptacles and lighting.

b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.

c. Internal panel wires on a common terminal shall have the same wire number assigned.

d. Wire and cable identification on each conductor or cable shall be limited to two lines of text.

e. Multi-conductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. All individual control conductors and instrumentation cable shall be identified at pull points as described above.

1) Armored multi-conductor cable shall be labeled using the conduit number shown on the plans, following the requirements for conduit markers as specified herein.

2. The following wiring numbering scheme shall be followed throughout the project and used for field wire numbers between control panels (including control stations, local control panels, process control systems, and vendor control panels), MCCs, field instruments, etc.

(ORIGIN LOC.) – (ORIGIN TERM.) / (DEST. LOC.) – (DEST. TERM.)

OR

(ORIGIN LOC.) – (ORIGIN TERM.)
(DEST. LOC.) – (DEST. TERM.)

Where:

ORIGIN LOC. = Originating panel or device location.
ORIGIN TERM. = Originating terminal at originating panel or device.
DEST. LOC. = Designation for destination panel or device.
DEST. TERM. = Terminal designation at destination panel or device, OR
DEST. TERM. = PLC I/O address at destination panel.

a. Equipment and field instruments are always identified as the origin.

b. Control panels are always identified as the destination.

c. Example: W94-1WFSH01-C / W94EELCP01-TB1-5

1) The origin is an eyewash flow switch.

a) Instrument Tag: W94-1W-FSH-01

b) Facility area code: W94 (De-Chlorination Facility)

c) Process / System Type: 1W (No. 1 Water)

d) Instrument Type: FSH (Flow Switch High)

e) Loop No.: 01

f) Terminal No.: C (Common)

2) The destination is a local control panel.

a) Panel Tag: W94-EE-LCP-01

b) Facility area code: W94 (De-Chlorination Facility)

c) Process / System Type: EE (Electrical Equipment)

d) Control Panel Type: LCP (Local Control Panel)

e) Loop No.: 01

f) Terminal Block No.: TB1

g) Terminal No.: 5

d. The following are examples of abbreviations used in the tagging process:

1) VCP – Vendor Control Panel

2) PCSP – Process Control System Panel

3) LCP – Local Control Panel

4) MCC – Motor Control Center

5) SWB – Switchboard

6) SWR - Switchgear

7) See the standard drawings for additional process and equipment abbreviations.

e. Location designation is the facility area code, equipment tag, and loop number with hyphens omitted.

f. Terminal designation in control panels is the terminal block number (terminal grouping number) followed by a hyphen and the actual number on the terminal where the conductor terminates. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.

1) Example: W94EELCP01-TB2-3

g. Terminal designation in MCCs is the starter cell or bucket number followed by a hyphen and the terminal number.

1) Example: W94EEMCCP37-2D-12

h. Terminal designation in field instruments or vendor panels is the terminal block number (terminal grouping number) followed by a hyphen and terminal number or symbol. The terminal designation is a terminal number or symbol, only, in the absence of terminal blocks or groupings.

1) Example: W94SBSFIT01-+

i. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (T1, T2, T3, etc.)

1) Example: W94DFEPMP01-T1

j. Terminal designations at control panels where the field conductor connects directly to a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project).

1) W:X:Y/Z for a discrete point or W:X:Y.Z for an analog point.

W = I for input, O for Output.
X = PLC number (1,2,3...).
Y = Slot number (01, 02, 03...).
Z = Terminal number (00, 01, 02...) for a discrete point or Word Number (1,2,3...) for an analog point.

2) Examples of discrete points: I:1:01/01, O:2:10/07

3) Examples of analog points: I:1:01.2, O:2:02.3

k. Terminal designations at control panels where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (C010). For common power after a fuse or neutrals after a switch the subsequent points will have an A, B, C, ... etc. suffix (C010A).

3. Case 1: Vendor Control Panel (VCP) to Process Control System Panel (PCSP):

Field wire number/label: A-B/C-D
A = Vendor Control Panel number without hyphen (VCP111).
B = Terminal number within VCP, MCC, or starter (manufacturer/vendor's standard with be acceptable).
C = Process control system panel without a hyphen (PCSP100).
D = Either PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C010).

Examples: VCP111-10/PCSP100-I:1:01/01.
VCP111-10/PCSP100-O:1:10/07.
VCP111-10/PCSP100-C100.

4. Case 2: Field instrument to PCSP:

Field wire number/label: C-D/E-F
C = Process control module without hyphen (PCSP100).
D = Either PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C010).
E = Field mounted instrument tag and loop numbers without hyphen (PIT300).
F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma.

Examples: PIT300-2,3/PCSP300-I:1:01.1.
TSH101-1/PCSP200-I:2:01/00.

5. Case 3: Motor Control Center (MCC) to PCSP:

Field wire number/label: B-C/D-G
B = Terminal number within VCP, MCC, or starter (manufacturer/vendor's standard will be acceptable).
C = Process control module without hyphen (PCSP100).
D = Either PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
G = MCC use actual starter designation in MCC i.e., MS131 without hyphen located in MCC-120.

Examples: MS131-10/PCSP100-I:1:01/01.
MS131-10/PCSP100-O:1:10/07.
MS131-10/PCSP100-C100.

6. Case 4: MCC to VCP:

Field wire number/label: A-B/G
A = Vendor Control Panel number without hyphen (VCP111).
B = Terminal number within VCP, MCC, or starter (manufacturer/vendor's standard will be acceptable).
G = MCC use actual starter designation in MCC i.e., MS131 without hyphen located in MCC-120.

Example: MS131-X2/VCP111-10.

7. Case 5: Motor leads to MCC

Field wire number/label: B-G/H-I
B = Terminal number within VCP, MCC, or starter (manufacturer/vendor's standard will be acceptable).
G = MCC use actual starter designation in MCC i.e., MS131 without hyphen located in MCC-120.
H = Equipment tag and loop number without hyphen (RWP131).
I = Motor manufacturer's standard motor lead identification (T1, T2, T3, etc.)

Example: RWP131-T1/MS131-T1.

8. Case 6: Remote or separately mounted starters or VFDs to PCSP:
Field wire number/label: B-C/D-J
B = Terminal number within VCP, MCC, or starter (manufacturer/vendor's standard will be acceptable).
C = Process control module without hyphen (PCSP100).
D = Either PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
J = Remote mounted starter or VFD tag and loop number without hyphen (MS121)
Examples: MS121-10/PCSP100-I:1:01/01.
MS121-10/PCSP100-O:2:10/07.
MS121-10/PCSP100-C010.

9. All spare conductors shall be terminated on terminal blocks and shall be identified as required for other field wires, with an "S" prefix.

Example: SMS315-21/PCM200-C125

3.3 CONTROL PANELS, MOTOR CONTROL CENTERS (MCC), AND SWITCHGEAR CONTROLS IDENTIFICATION

A. Provide nameplates for control panels, MCCs, and switchgear as shown on the elevation and/or other drawings.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. Perform field tests as herein specified by a certified, independent Testing Firm as specified herein. The Testing Firm shall provide all material, equipment, labor and technical supervision to perform such tests.

2. It is the intent of these tests to assure that all electrical equipment supplied is operational and within industry and manufactures tolerances and is installed in accordance with manufacturer's design and specifications.

3. The Testing Firm shall maintain a written record of the tests and upon completion of project, assemble and certify a final test report for review by the District.

4. Testing is also required for existing equipment as indicated on the Drawings.

1.2 QUALITY ASSURANCE

A. Experience:

1. The Testing Firm shall be a corporately independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the Testing Firm.

2. The Testing Firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

3. The Testing Firm shall have been engaged in such practices for a minimum of five years.

4. The Testing Firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the InterNational Electrical Testing Association (NETA) constitutes proof of such criteria.

5. The lead, on-site technical person shall be currently certified by the NETA in Electrical Power Distribution System Testing. Submit copy of qualifications and certifications for review by the District.

6. Testing firm shall utilize only full-time technicians who are regularly employed by the firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians or linemen may assist, but may not perform testing or inspection services.

7. The Testing Firm shall submit proof of the above qualifications with bid documents when requested.

8. The Testing Firm shall be an independent organization as defined by OSHA Title 29, Part 1936, and the NETA.

9. All instruments used by the Testing Firm to evaluate electrical performance shall meet NETA's Acceptance Testing Specifications for Calibration of Test Instruments.

10. The Testing Firm shall be:

    a. Power Systems Testing Co., Livermore, California

    b. Pacific Power Testing, San Leandro, California

    c. Apparatus Testing and Engineering, Rancho Cordova, California

    d. Associated Power Solutions, Concord, California

    e. Or equal.

1.3 SUBMITTALS

A. The Contractor shall furnish submittals for approval as outlined below:

1. Proposed field acceptance tests

2. Field acceptance test reports

3. List of proposed testing equipment

1.4 REFERENCES

A. National Electrical Testing Association (NETA)

1.5 SCHEDULING

A. Notify the Testing Firm when equipment becomes available for acceptance tests. Coordinate Work with other systems.

B. The Contractor and Testing Firm shall coordinate testing with process operations.

C. Notify the District a minimum of two weeks prior to commencement of any testing.

1.6 SYSTEM DESCRIPTION

A. Performance requirements

1. Testing and calculations required under this Section shall be per the guidelines specified in the most recent NETA publication “Acceptance Testing Specification for Electric Power Distribution Equipment and Systems”.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Perform general equipment inspection and checking procedures recommended by the manufacturer and as specified in other Sections of these specifications prior to and in addition to tests performed by the Testing Firm specified herein.

B. Supply a suitable and stable source of electrical power to each test site. The Testing Firm shall specify the specific power requirements.

C. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported, corrected and retested all at no additional cost to the District.

D. Allow the District up to two weeks to perform arc flash evaluation on power distribution panels in the Oxygen Production Facility. Contractor shall provide 6 week notice to the District to complete this evaluation. Contact the District for existing arc flash category of the S3 Switchgear, Substation U10 switchgear, Substation U11 switchgear, MCC-P15, MCC-P16, and MCC- P17 when the equipment is energized.

3.2 FIELD QUALITY CONTROL

A. Site Testing

1. Testing and commissioning shall be performed in accordance with the latest revision of NETA ATS “Acceptance Testing Specifications” Standard for Electrical Power Distribution Equipment and Systems.

2. Perform testing in two separate phases. Submit a typed report after each testing phase is completed. Submit the report to the District for review, comment and record purposes. All reports submitted by the Testing Firm shall meet NETA's ATS for Test Reports.

3. The report shall include a data sheet for each component (i.e. cable, circuit breaker, transformer, relay, motor, disconnect, etc.) tested. Include in each data sheet the testing equipment model number and last certified

calibration date, weather conditions at the time of the test (i.e. temperature, humidity, sunny, rain, etc.) the tester's observation and findings, discrepancies, any remedial work performed or act to resolve problems, technical parameters obtained during the tests, as left settings of all devices, and a statement indicating the equipment is ready to be energized. The report shall contain a statement indicating the equipment was tested in accordance with the procedures outlines in the latest editions of the NETA's ATS.

B. Phase 1 – Testing requirements to be performed before the equipment is energized.

1. Inspect and mechanically operate all circuit breakers, power disconnect switches, transfer switches, and circuit breakers/disconnect switches installed within equipment furnished under other divisions of these specifications.

2. Set, calibrate and test all protective devices including but not limited to, circuit breakers, protective relays, timing devices, motor overload, electrical protective devices located with equipment furnished under other sections of these specifications.

3. Verify that protective relay, current transformers, ground sensing devices, lightning arresters, surge capacitor, fuses, furnished are in accordance with the approved shop drawings and the Protective Device Selective Coordination Study provided by the District.

4. Test all new low voltage (less than 2000V) power system cables as specified under Section 26 05 19 Low Voltage Electrical Power Conductors and Cables; test all conductors over 600V as specified under Section 26 05 13 Medium Voltage Cables.

5. Verify that all power, breakers, and control power fuses installed under this project are in accordance with the manufacturer's approved shop drawings, the Protective Device Selective Coordination Study and the CEC. Replace breakers of incorrect sizes or fuses found to be of the incorrect rating.

6. Verify control circuits and functionality of the controls for all motors, automatic transfer systems, remote protective device (i.e. wiring for differential protection relays, alarms systems, safety interlocks emergency stop controls, motor, transformer and generator protective devices). The functionality shall be in accordance with the approved control schematics, wiring diagrams or functional descriptions.

7. Check motor nameplates for correct phase and voltage. Verify motor bearings for proper lubrication.

8. Inspect each piece of electrical equipment in areas designated as NEMA 4 or NEMA 4X to ensure that equipment of proper rating is installed.

9. Verify all lightning arrestors and surge capacitors (including the motor termination box), service entrance equipment, power distribution equipment, motors, control centers, utilization equipment, etc, are properly grounded.

10. Verify the resistance to ground of all power distribution equipment is 5 ohms or less.

11. Verify all terminations at the transformers, service entrance and distribution switchgear/switchboards, motor control centers, panelboards and motors are correctly made and properly torqued.

12. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points. Verify the resistance is 0.5 ohms or less.

13. Refer to the individual equipment and material specification sections for additional testing requirements.

14. Verify all circuit breaker ratings and settings are as required by the Contract Documents or as amended during shop drawing review. Advise the District of discrepancies and make changes as directed by the District.

15. Verify proper operation of accessories, devices and motor interlocks.

16. Verify grounding of instrumentation equipment and line surge protection equipment.

17. Provide test report as specified in Paragraph A.2 above. Report shall be reviewed and approved by the District prior to approval for energizing system..

C. Phase 2 - After the electrical distribution equipment has been energized perform the following tests:

1. Verify phase rotation at the service entrance, distribution switchgear, motor control centers, and panelboards.

2. Jog all motors to verify rotation. Disconnect the driven equipment if damage could occur due to incorrect rotation. If the rotation is found to be incorrect, reconnect the motor terminations at the motor terminal box.

3. Check all instrument wiring and verify grounding is in accordance with the manufacture's recommendations.

4. Check the full load current draw of each motor. Where power factor correction capacitors are provided, the capacitor shall be in the circuit at the time of the measurement. Compare the measured value to the rating of the thermal overload devices furnished and verify compliance with the CEC.

5. Submit a typed list record for each motor. The list shall include the motor name and number, the MCC and MCC bucket to which the motor is connect, the overload rating, and the motor circuit protector rating and setting. The rating and setting of the overload device and the motor circuit protector shall be compared to the ratings allowed by the CEC.

6. The Testing Company shall obtain the approved/corrected Protective Device Selective Coordination Study before starting the testing and shall become familiar with the Study. All discrepancies shall be addressed before the testing begins.

7. Submit a typed report as specified in Paragraph A.2 above. The report shall be stamped and signed by a California Registered Professional Engineer.

D. Thermographic Survey

1. Contractor shall perform a thermographic survey on all current-carrying devices specified this section or where indicated on the Drawings.

2. Perform all standard visual and mechanical inspections listed in NETA ATS, for Thermographic Surveys.

a. Perform thermographic survey when at least 25 percent load is applied to the system.

b. Use equipment IR ports to perform the inspection where installed.

3.3 INSTRUMENT TRANSFORMERS

A. Instrument Transformers shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections listed in NETA ATS, paragraph 7.10 for Instrument Transformers.

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.

2. Perform all standard electrical tests listed in NETA ATS, paragraph 7.10.1 for Current Transformers.

1) Metal in oil analysis

3.4 MEDIUM AND HIGH VOLTAGE SURGE ARRESTERS

A. Medium Voltage Surge Arresters shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.19.2 for Surge Arresters, Medium and High Voltage Surge Protection Devices:

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3.5 PROTECTIVE RELAYS

A. Existing protective relays as indicated on the Drawings will be tested as required in this specification section. Additionally, protective Relays specified in Section 26 09 16 Electrical Controls and Relays shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.9 for Protective Relays:

a. Set relays in accordance with the coordination study or setting sheet provided by the District.

2. Perform all standard functional operation tests listed in NETA ATS, paragraph 7.9.3 for Protective Relay types specified in Section 33 72 33.

3. Perform the following optional functional operation tests listed in NETA ATS, paragraph 7.9.3 for Protective Relay:

a. 50 Instantaneous Overcurrent Relays:

1) Determine time delay.

b. 67 Directional Overcurrent Relays:

1) Determine maximum torque angle.

2) Plot operating characteristics

4. Perform the following additional system tests:

a. Relay Communications:

1) Verify the correct operation of the IRIG-B time-code demodulator and each programmable demodulated IRIG-B

output to the connected relays where applicable.

2) Verify proper serial network operation between the communications processor and each connected protective relay.

3) Verify the proper Ethernet network and DNP 3.0 serial network operation to the communications processor.

3.6 MEDIUM VOLTAGE VACUUM CIRCUIT BREAKERS

A. Medium Voltage Vacuum Circuit Breakers shall be tested where indicated on the Drawings and be tested as follows:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.6.3 for Medium Voltage Vacuum Circuit Breakers:

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3.7 LOW VOLTAGE CONTROL CABLE

A. Low Voltage Electrical Power Conductors and Cable specified in Section 26 05 19 shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.3.2 for Low Voltage Cables:

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for >600 volt rated cable. Test duration shall be one minute.

2. Perform the following additional electrical tests on shielded control cable:

a. Inspect shield grounding, cable support, and termination.

b. Perform a shield-continuity test on each cable by ohmmeter method.

3.8 MEDIUM VOLTAGE POWER CABLES

A. Medium Voltage Power Cables specified in Section 26 05 13 shall be field inspected and tested as follows:

1. Perform all standard and optional visual and mechanical inspections listed in NETA ATS, paragraph 7.3.3 for Medium Voltage Cables:

   a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

2. Perform all standard electrical tests listed in NETA ATS, paragraph 7.3.3 for Medium Voltage Cables:

   a. Perform an acceptance test on cables, including terminations and joints, after cable system installation and before the cable system is placed into service. In accordance with ANSI/IEEE 400, ICEA S-93-639/NEMA WC 74, ICEA S-94-649 and ICEA S-97-682, testing will be performed by means of direct voltage (dc). Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Test voltages shall not exceed 80 percent of cable manufacturer's factory test value or the maximum test voltage in NETA ATS Table 100.6:

      1) Ensure that the input voltage to the test set is regulated.

      2) Current-sensing circuits in test equipment, when available, shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

      3) Record wet- and dry-bulb temperatures or relative humidity and temperature.

      4) Test each cable section individually.

      5) Test each conductor individually with all other conductors grounded. Ground all shields.

      6) Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method, as necessary.

      7) Ensure that the maximum test voltage does not exceed the limits for terminators specified in ANSI/IEEE 48, IEEE 386, or manufacturer's specifications.

8) Raise the conductor to the specified maximum test voltage in increments that do not exceed the cable rating record leakage current at each step. Hold for 15 minutes and record leakage current at 30 seconds and subsequent 1 minute intervals. Refer to NETA ATS Table 100.6.

9) Reduce the test set potential to zero and measure residual voltage at discrete intervals.

10) Apply grounds for a time period adequate to drain all insulation stored charge.

3.9 GROUNDING SYSTEMS

A. Grounding Systems specified in Section 26 05 26 shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.13 for Grounding Systems.

3.10 MEDIUM VOLTAGE MOTORS

A. Medium Voltage Motors furnished by the District for this project shall be field inspected and tested as follows:

1. Perform all standard visual and mechanical inspections listed in NETA ATS, paragraph 7.15.1 for AC Motors and Generators.

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. NOT USED.

3.11 LOW VOLTAGE CIRCUIT BREAKERS

A. All Low Voltage Circuit Breakers shall be field inspected and tested as follows and where indicated on the Drawings:

1. Perform all standard visual and mechanical inspections and electrical tests listed in NETA ATS, paragraph 7.6.1.1 for Low-Voltage Insulated/Molded Case Circuit Breakers.

a. Inspect bolted electrical connections for high resistance by verifying the tightness of accessible bolted electrical connections

by calibrated torque-wrench method in accordance with manufacturer's published data.

2. Perform the following electrical test listed in NETA ATS, paragraph 7.6.1.1 for Low-Voltage Insulated/Molded Case Circuit Breakers:

a. Perform insulation-resistance test all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. Perform surge comparison tests. For units with solid-state components, follow manufacturer's recommendations.

3.12 STATIC UNINTERRUPTIBLE POWER SUPPLIES

A. Static uninterruptible power supplies specified in 40 95 13 – Process Control Panels and Hardware shall be field inspected and tested as follows:

Perform all standard inspections and tests listed in NETA ATS, paragraph 7.22.2 for Uninterruptible Power Systems.

1. Performance Tests:

a. Verify performance to be in accordance with the specified criteria; measure battery discharge and recharge time; simulate battery discharge and recharge time; simulate fault in each system to verify monitoring and indicator operation; simulate fault in each system component and normal power; operate unit for eight hours on normal AC power at rated load using resistive load bank or actual loads; operate at rated load on battery for one hour to verify rating; and other tests as recommended by the manufacturer.

END OF SECTION

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SECTION 26 09 16

ELECTRICAL CONTROLS AND RELAYS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes

1. Furnish and install the equipment in accordance with this Section and applicable reference standards listed in Article 1.3.

2. This section includes the supply and installation of a complete relay protection system for new equipment and modifications to existing equipment as detailed on the Drawings and as described in this Specification.

3. Modifications to the existing MAC Motor Control Centers will be required to install the new motor protection relays and test switches. The Contractor shall coordinate with the District prior to doing this work.

4. Associated devices are specified in this section such as the motor stator RTD module and RTD cables including communication cable (fiber) from the module to the motor management relay.

5. Test switches as specified herein shall be mounted in the MAC Motor Control Centers as shown on the Drawings.

6. Training and software requirements as specified herein.

B. Related Requirements

1. Section 26 05 00 – Common Work Results for Electrical

1.2 NOT USED.

1.3 REFERENCES

A. Reference Standards

1. The protective relays shall comply with the applicable portions of ANS/IEEE and NEMA standards.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.5 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. The following information shall be submitted to the Engineer

1. System description including an overview of the system provided with detailed description of system

2. Bill of Material including a complete listing of all relays, hardware, devices, training, and startup services being supplied

C. Wiring diagrams and control schematics representing the interconnection of the protective relays to the circuit breakers affected by their protective function.

D. Final submittal data shall include a systems operation manual, which includes all the information required by Section 1.05.

E. The operation manual shall include the following information

1. A system description overview, descriptive bulletins and/or sales aids covering all components in the system.

2. A maintenance section including all instruction leaflets and technical data necessary to set-up, change set-up parameters, and maintain the communicating devices and sensors.

F. A detailed startup report, including a list of trained customer personnel shall be provided

G. Training materials for maintenance and operation staff for review and approval prior to training

H. Published time-current curves (on full logarithmic paper) and instruction manuals of all protective relays

1.6 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements and as follows.

1. The manufacturer of the equipment shall have been regularly engaged in the manufacture of protective relay devices for a period of at least 5 years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications.

C. NOT USED.

D. NOT USED.

PART 2 – PRODUCTS

2.1 NOT USED.

A. NOT USED.

B. NOT USED.

2.2 MOTOR MANAGEMENT RELAY

A. Motor protection shall be provided using a relay with complete protection, metering, and monitoring functions. The relay will be applied on induction motors of 60 Hz. The relay shall be a Schweitzer Engineering Laboratories model 710-5, part number: 071050E1A1A9X7585A8A0. No substitutions allowed.

B. The relay shall be a microprocessor-based multifunctional type that operates from the 5-ampere secondary output of current transformers.

C. The relay shall provide the following protection functions

1. Instantaneous over-current (50)
2. Time over-current (51)
3. Current unbalance (46)
4. Neutral over-current (50N)
5. Stator thermal modeling and RTD (49)
6. Load Jam (50PLJ)
7. Locked Rotor (50PLR)
8. Incipient cable fault (50INC)
9. Starts per hour (66)
10. Undercurrent (37)
11. Bearing over-temperature (38)
12. Phase differential (87)
13. Underfrequency (81)
14. Load control power current thermal capacity (90)

15. Over and under voltage (59/27)

16. Inverse time over and under voltage (59I/27I)

17. Voltage phase reversal (47)

18. Broken rotor bar detector (BBD)

D. Monitoring and metering functions shall include:

1. RMS current, negative sequence current, voltage, three phase power, temperature (via RTDs), and analog inputs

2. An event record which shall maintain a record of the last 40 events

E. The protective relay shall include the following user interfaces:

1. RMS current, negative sequence current, voltage, three phase power, and temperature (via the RTDs).

2. A touchscreen and control buttons located on the front panel.

3. LED indicators located on the front panel which shall indicate the status of the protection relay, motor, and output relays.

4. An RS232 port located on the front panel with a baud rate of 9600 bps.

5. Two RS485 ports located on the rear of the unit with baud rates from 300 to 19,200 bps.

6. The communications ports shall allow simultaneous independent access using DNP 3.0 Ethernet protocol via 10/100Base-T Copper RJ45 connector.

7. GPS clock connectivity with IRIG-B/PTC connection.

8. Windows® based PC software which enables set point programming, file storage, on-line help, and real time display of status and measured data.

F. Power Requirement:

1. Provide relay with provisions for a 120Vac, 60Hz power source.

2.3 MOTOR STATOR RTD MODULE AND CABLES

A. Stator RTD module shall be Schweitzer Engineering Laboratories model 2600, part number: 2600A01X, No substitutions allowed. The modules are located in the RIO MAC Panels as shown on the Drawings.

B. Module shall be configured for 120/240VAC power.

C. Fiber-optic connection shall be type ST connectors.

D. Fiber-optic cable multimode 62.5/200 micrometer core diameter, shall be Schweitzer Engineering Laboratories part number: C807Z010SSX0030, No substitutions allowed.

E. Stator RTD extension cable shall be shielded, 3 conductor, 24AWG, FEP Teflon insulation, Automation Direct part number: RTDW-24-1S-F-1 or Equal.

2.4 TEST SWITCHES

A. Test switches shall be ABB model FT-19R part number: FR2G288569001 or equal. The test switches shall be installed at the existing MAC Motor Control Centers as shown on the Drawings.

B. Provide cutouts in existing enclosure that are sized to match the size of the test switch provided.

2.5 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

2.6 SPARE PARTS

A. Provide one (1) spare motor protection relay SEL 710-5 and associated hardware.

B. Provide one (1) spare RTD module SEL-2600 and associated hardware.

C. Provide one (1) spare fiber optic cable for connection between SEL 710-5 and SEL-2600.

D. Provide four (4) spare USB serial cable SEL-C662.6 feet length minimum.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. After installation, the equipment shall be field tested for operation and conformance in accordance with Division 26.

C. Perform field tests prior to energizing equipment in a staged sequence to minimize interruptions to the treatment plant. Equipment shall not be energized or placed back into operation without the permission of the Engineer. The field tests shall be witnessed by the Engineer and certified by the Contractor.

D. Field-testing for the protective relays shall be performed by and in accordance with the recommendations of the manufacturer's representative.

E. Compressor motor has a limited number of start cycles per hour. Plan and coordinate accordingly when performing testing to optimize the number of tests within a given amount of time.

F. Contractor to migrate existing GE-469 Multilin motor start and protection configuration settings into new SEL-710-5 and make necessary tweaks to ensure the final settings will operate correctly and in accordance to the control narrative Section 40 60 01B Control Narrative.

1. See attached GE 469 relay settings for each of the existing MAC motor in Appendix A at the end of this section.

G. Obtain new main air compressor motor parameters and data information from the District for configuration of the new motor protection relay.

3.2 FIELD SERVICES AND TRAINING

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein. A qualified service representative from the motor management relay manufacturer shall perform field services after equipment delivery, shall be performed:

1. Assist in the installation of the equipment

2. Assist in the performance of field tests

3. Observe and assist initial operations

4. Program and configure the relays and motor stator RTD modules.he relay

5. Train the maintenance staff in the care, operation, maintenance and testing and configuration of the motor protection relays and equipment. At a minimum, training shall include the following:

a. Overview on the functionalities and capabilities of the motor protection relays and RTD modules;

b. Installation of the AcSELerator Quickset software or SEL relay configuration application onto District provided laptop. Manufacturer representative shall provide CD or jump drive with the latest AcSELerator Quickset software for District to install.

c. Laptop (provided by District) communication setups and connections to the relays and RTD modules;

d. Navigation of the various screens in the motor protection relays and RTD modules via AcSELerator Quickset;

e. Discuss and explain the various meanings, functions, equations, logics, tags, etc in the AcSELerator Quickset and protection relay that is associated with the relevant parameters, important setpoints/parameters, or changes to control the compressor motors for the job;

f. Include printouts and handouts of the actual parameter values and conditional statements that are set in the relays for the training;

g. Procedures on simulating and performing force outputs from the relays;

h. Provide handouts and training procedures to all attendees (total 12).

6. Train the plant Operations staff on the overview of the operation and functionalities of protection relays and the navigation of the units through the touchscreen for various displays.

7. Both maintenance staff and operations staff training shall occur at District facilities in Oakland, California. A minimum of four (4) weeks notice shall be provided to the District for scheduling training. A minimum of 16 hours training shall be provided for maintenance staff of up to 12 (12) people. Maintenance staff training shall spread into four (4) sessions and four (4) hours per session to allow for breaks in between. An additional minimum of eight (8) hours training shall be provided for operations staff of up to twenty (25) people. Operation staff training shall split into four (4) sessions and two (2) hours per session.

B. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

C. The Contractor shall provide equipment start-up services in accordance with Division 26.

D. The Contractor shall provide a field report from the manufacturer's representatives for each visit to the Site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

3.3 ACCEPTANCE TESTING

A. The Contractor shall provide and perform acceptance testing for the new protective relays in after the completion of the field tests. The acceptance testing shall be witnessed by the Engineer, Owner and certified by the Contractor.

B. Acceptance testing inspection shall be performed, in a staged sequence to minimize interruptions to the facility. Inspection shall include the following

1. Physical, electrical and mechanical conditions shall be inspected

2. All connections shall be inspected for high resistance

3. Electrical and mechanical interlock systems and control circuits shall be checked for proper operation

4. Protective relays and instruments shall be inspected for proper operation

5. Pickup and timing tests shall be performed for each protective relay

C. All tests and values shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specifications.

D. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specifications.

3.4 FIELD ADJUSTMENTS

A. The motor management relays shall implement the settings and be configured in the field by District Staff.

3.5 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.6 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.7 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

B. Provide final (as-left) version of the relays configuration file to District. Filenames shall be clearly named to include the main air compressor equipment number and date of the file.

END OF SECTION

O2_COMPRESSOR_1-1_469.469
C:\USERS\RMAC\ONEDRIVE - EAST BAY MUNICIPAL UTILITY DISTRICT\DOCUMENTS\RMAC\O2 COMPRESSOR\GE MULTILIN FILES\MAC 1-1
DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.9X
SERIAL NUMBER: A3000359
DESCRIPTION: (NONE)
TEXT COLOR

469 SETUP

PREFERENCES

Default Message Cycle Time	2.0 s
Default Message Timeout	300 s
Average Motor Load Calculation Period	15 min
Temperature Display Units	Celsius
Trace Memory Trigger Position	25 %
Trace Memory Buffers	8 x 14 cycles
Display Update Interval	0.4 s
Motor Load Filter Interval	0 cycles

MESSAGE SCRATCHPAD

First Scratchpad Message	Text 1
Second Scratchpad Message	Text 2
Third Scratchpad Message	Text 3
Fourth Scratchpad Message	Text 4
Fifth Scratchpad Message	MULTILIN SR469 Motor Management Relay

SYSTEM SETUP

CURRENT SENSING

Phase CT Primary	200 A
Motor Full Load Amps	145 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A

VOLTAGE SENSING

VoltageTransformer Connection Type	Open Delta
Voltage Transformer Ratio	35.00 :1
Motor Nameplate Voltage	4160 V

POWER SYSTEM

Nominal System Frequency	60 Hz
System Phase Sequence	ABC

REDUCED VOLTAGE

Reduced Voltage Starting	On/Yes
Control Relays for Reduced Voltage Starting	Auxiliary 3
Transition On	Current and Timer
Reduced Voltage Start Level	300 % FLA
Reduced Voltage Start Timer	10 s
Incomplete Sequence Trip Relays	Trip

DIGITAL INPUTS

STARTER

Starter Status Switch	Start Aux a

INPUT 1

Assignable Input 1 Function	General Sw. A
General Switch A Name	Incomplet SQ
General Switch A Normal State	Normally Open
General Switch A Block Input From Start	0 s
General Switch A Alarm Relays	Alarm
General Switch A Alarm Delay	5.0 s
General Switch A Trip	Latched
General Switch A Trip Relays	Trip
General Switch A Trip Delay	12.0 s

OUTPUT RELAYS

TRIP RELAY

Force R1 Operate Time	0 s

ALARM RELAY

Force R4 Operate Time	0 s

AUX RELAY 2

Force R2 Output Operate Time	0 s

AUX RELAY 3

Force R3 Operate Time	0 s

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.9X
SERIAL NUMBER: A3000359
DESCRIPTION: (NONE)
TEXT COLOR

BLOCK START RELAY

Force R5 Operate Time	0 s

PROTECTION
THERMAL MODEL
469 THERMAL MODEL

Curve Style	Standard
Overload Pickup Level	1.10 FLA
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	1.00
Thermal Capacity Alarm	Unlatched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Overload Trip Relays	Trip

OVERLOAD CURVE

Standard Overload Curve Number	4

OVERLOAD ALARM

Overload Alarm	Unlatched
Overload Alarm Relays	Alarm
Overload Alarm Delay	60.0 s

MECHANICAL JAM

Mechanical Jam Trip	Latched
Mechanical Jam Trip Relays	Trip
Mechanical Jam Pickup	1.50 xFLA
Mechanical Jam Delay	1 s

UNDERCURRENT

Block Undercurrent from Start	0 s

CURRENT UNBALANCE

Current Unbalance Alarm	Unlatched
Current Unbalance Alarm Relays	Alarm
Current Unbalance Alarm Pickup	15 %
Current Unbalance Alarm Delay	1 s
Current Unbalance Trip	Latched
Current Unbalance Trip Relays	Trip
Current Unbalance Trip Pickup	20 %
Current Unbalance Trip Delay	1 s

GROUND FAULT

Ground Fault Alarm	Unlatched
Ground Fault Alarm Relays	Alarm
Ground Fault Alarm Pickup	0.50 CT
Intentional GF Alarm Delay	10 ms
Ground Fault Trip	Latched
Ground Fault Trip Relays	Trip
Ground Fault Trip Pickup	1.00 CT
Intentional GF Trip Delay	150 ms

PHASE DIFFERENTIAL

Phase Differential Trip	Latched
Phase Differential Trip Relays	Trip
Differential Trip Pickup While Starting	0.10 CT
Differential Trip Delay While Starting	0 ms
Differential Trip Pickup While Running	0.10 CT
Differential Trip Delay While Running	0 ms

JOGGING BLOCK

Jogging Block	On/Yes
Maximum Starts/Hour Permissible	2
Time Between Starts	15 min

RTD TEMPERATURE
RTD TYPES

Stator RTD Type	100 Ohm Platinum
Bearing RTD Type	10 Ohm Copper

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.9X
SERIAL NUMBER: A3000359
DESCRIPTION: (NONE)
TEXT COLOR

RTD TYPES (continued from last page)

Ambient RTD Type	10 Ohm Copper
Other RTD Type	10 Ohm Copper

RTD #1

RTD #1 Application	Stator
RTD #1 Name	Stator#1
RTD #1 Alarm	Unlatched
RTD #1 Alarm Relays	Alarm
RTD #1 Alarm Temperature	115 °C
RTD #1 Trip	Latched
RTD #1 Trip Voting	RTD #1
RTD #1 Trip Relays	Trip
RTD #1 Trip Temperature	125 °C
RTD #1 Hi Alarm	Unlatched
RTD #1 Hi Alarm Relays	Alarm
RTD #1 Hi Alarm Level	120 °C

RTD #2

RTD #2 Application	Stator
RTD #2 Name	

RTD #3

RTD #3 Application	Stator
RTD #3 Name	

RTD #4

RTD #4 Application	Stator
RTD #4 Name	

RTD #5

RTD #5 Application	Stator
RTD #5 Name	

RTD #6

RTD #6 Application	Stator
RTD #6 Name	

RTD #7

RTD #7 Application	Bearing
RTD #7 Name	

RTD #8

RTD #8 Application	Bearing
RTD #8 Name	

RTD #9

RTD #9 Application	Bearing
RTD #9 Name	

RTD #10

RTD #10 Application	Bearing
RTD #10 Name	

RTD #11

RTD #11 Application	Other
RTD #11 Name	

RTD #12

RTD #12 Application	Ambient
RTD #12 Name	

ALARMS

Open RTD Sensor Alarm	Latched
Open RTD Sensor Alarm Relays	Alarm
RTD Short/Low Temp Alarm	Latched
RTD Short/Low Temp. Alarm Relays	Alarm

VOLTAGE ELEMENTS
UNDERVOLTAGE

Undervoltage Active Only If Bus Energized	On/Yes

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.9X
SERIAL NUMBER: A3000359
DESCRIPTION: (NONE)
TEXT COLOR

UNDERVOLTAGE (continued from last page)

Undervoltage Trip	Unlatched
Undervoltage Trip Mode	1-Phase
Undervoltage Trip Relays	Trip
Undervoltage Trip Pickup	0.75 Rated
Starting Undervoltage Trip Pickup	0.75 Rated
Undervoltage Trip Delay	4.0 s

PHASE REVERSAL

Voltage Phase Reversal Trip	Latched
Voltage Phase Reversal Trip Relays	Trip

POWER ELEMENTS

POWER FACTOR

Block Power Factor Element from Start	1 s

REACTIVE POWER

Block kvar Element from Start	1 s

UNDERPOWER

Block Underpower From Start	0 s

REVERSE POWER

Block Reverse Power From Start	0 s

TORQUE SETUP

Stator Resistance	0.004 mOhm
Pole Pairs	2
Torque Unit	Newton-meter

OVERTORQUE SETUP

Overtorque Alarm Relays	Alarm
Overtorque Alarm Level	4000.0 Nm
Overtorque Alarm Delay	1.0 s

STARTER FAILURE

Starter Failure Alarm (Starter Failure)	Latched
Starter Type	Contactor
Starter Failure Alarm Relays	Alarm
Starter Failure Alarm Delay	500 ms

CURRENT DEMAND

Current Demand Period	15 min

KW DEMAND

kW Demand Period	15 min

KVAR DEMAND

kvar Demand Period	15 min

KVA DEMAND

kVA Demand Period	15 min

PULSE OUTPUT

Positive kWh Pulse Output Relay	Auxiliary2
Positive kWh Pulse Output Interval	100 kWh
Running Time Pulse Relay	Auxiliary2
Running Time Pulse Interval	1 sec

ANALOG I/O

ANALOG INPUT 1

Analog Input 1 Setup	4-20 mA
Analog Input 1 Name	Analog I/P 1
Analog Input 1 Units	Units
Analog Input 1 Maximum (analog in 1)	1000
Block Analog Input 1 From Start	0 s

ANALOG INPUT 2

Analog Input 2 Setup	4-20 mA
Analog Input 2 Name	Analog I/P 2
Analog Input 2 Units	Units

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.9X
SERIAL NUMBER: A3000359
DESCRIPTION: (NONE)
TEXT COLOR

ANALOG INPUT 2 (continued from last page)

Analog Input 2 Maximum (analog in 2)	1000
Block Analog Input 2 From Start	0 s

ANALOG INPUT 3

Analog Input 3 Setup	4-20 mA
Analog Input 3 Name	Analog I/P 3
Analog Input 3 Units	Units
Analog Input 3 Maximum (analog in 3)	1000
Block Analog Input 3 From Start	0 s

ANALOG INPUT 4

Analog Input 4 Setup	4-20 mA
Analog Input 4 Name	Analog I/P 4
Analog Input 4 Units	Units
Analog Input 4 Maximum (analog in 4)	1000
Block Analog Input 4 From Start	0 s

ANALOG OUTPUTS

Analog Output 1 Selection	None
Analog Output 2 Selection	None
Analog Output 3 Selection	None
Analog Output 4 Selection	None

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.6X
SERIAL NUMBER: A3000360
DESCRIPTION: (NONE)
TEXT COLOR

469 SETUP

PREFERENCES

Default Message Cycle Time	2.0 s
Default Message Timeout	300 s
Average Motor Load Calculation Period	15 min
Temperature Display Units	Celsius
Trace Memory Trigger Position	25 %
Trace Memory Buffers	8 x 14 cycles
Display Update Interval	0.4 s
Motor Load Filter Interval	0 cycles

MESSAGE SCRATCHPAD

First Scratchpad Message	Text 1
Second Scratchpad Message	Text 2
Third Scratchpad Message	Text 3
Fourth Scratchpad Message	Text 4
Fifth Scratchpad Message	MULTILIN SR469 Motor Management Relay

SYSTEM SETUP

CURRENT SENSING

Phase CT Primary	200 A
Motor Full Load Amps	145 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A

VOLTAGE SENSING

VoltageTransformer Connection Type	Open Delta
Voltage Transformer Ratio	35.00 :1
Motor Nameplate Voltage	4160 V

POWER SYSTEM

Nominal System Frequency	60 Hz
System Phase Sequence	ABC

SERIAL COMM CONTROL

Serial Communication Control	On/Yes
Assign Start Control Relays	Auxiliary 2

REDUCED VOLTAGE

Reduced Voltage Starting	On/Yes
Control Relays for Reduced Voltage Starting	Auxiliary 3
Transition On	Current and Timer
Reduced Voltage Start Level	300 % FLA
Reduced Voltage Start Timer	10 s
Incomplete Sequence Trip Relays	Trip

DIGITAL INPUTS

STARTER

Starter Status Switch	Start Aux a

INPUT 1

Assignable Input 1 Function	General Sw. A
General Switch A Name	Incomplet Sq
General Switch A Normal State	Normally Open
General Switch A Block Input From Start	0 s
General Switch A Alarm Relays	Alarm
General Switch A Alarm Delay	5.0 s
General Switch A Trip	Latched
General Switch A Trip Relays	Trip
General Switch A Trip Delay	12.0 s

OUTPUT RELAYS

TRIP RELAY

Force R1 Operate Time	0 s

ALARM RELAY

Force R4 Operate Time	0 s

AUX RELAY 2

O2_COMP_1_2_469.469
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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.6X
SERIAL NUMBER: A3000360
DESCRIPTION: (NONE)
TEXT COLOR

AUX RELAY 2 (continued from last page)

Force R2 Output Operate Time	0 s

AUX RELAY 3

Force R3 Operate Time	0 s

BLOCK START RELAY

Force R5 Operate Time	0 s

PROTECTION
THERMAL MODEL
469 THERMAL MODEL

Curve Style	Standard
Overload Pickup Level	1.17 FLA
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	1.00
Thermal Capacity Alarm	Unlatched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Overload Trip Relays	Trip

OVERLOAD CURVE

Standard Overload Curve Number	4

OVERLOAD ALARM

Overload Alarm	Unlatched
Overload Alarm Relays	Alarm
Overload Alarm Delay	60.0 s

MECHANICAL JAM

Mechanical Jam Trip	Latched
Mechanical Jam Trip Relays	Trip
Mechanical Jam Pickup	1.50 xFLA
Mechanical Jam Delay	1 s

UNDERCURRENT

Block Undercurrent from Start	0 s

CURRENT UNBALANCE

Current Unbalance Alarm	Unlatched
Current Unbalance Alarm Relays	Alarm
Current Unbalance Alarm Pickup	15 %
Current Unbalance Alarm Delay	1 s
Current Unbalance Trip	Latched
Current Unbalance Trip Relays	Trip
Current Unbalance Trip Pickup	20 %
Current Unbalance Trip Delay	1 s

GROUND FAULT

Ground Fault Alarm	Unlatched
Ground Fault Alarm Relays	Alarm
Ground Fault Alarm Pickup	0.50 CT
Intentional GF Alarm Delay	10 ms
Ground Fault Trip	Latched
Ground Fault Trip Relays	Trip
Ground Fault Trip Pickup	1.00 CT
Intentional GF Trip Delay	150 ms

PHASE DIFFERENTIAL

Phase Differential Trip	Latched
Phase Differential Trip Relays	Trip
Differential Trip Pickup While Starting	0.10 CT
Differential Trip Delay While Starting	50 ms
Differential Trip Pickup While Running	0.10 CT
Differential Trip Delay While Running	20 ms

JOGGING BLOCK

Jogging Block	On/Yes
Maximum Starts/Hour Permissible	2
Time Between Starts	15 min

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.6X
SERIAL NUMBER: A3000360
DESCRIPTION: (NONE)
TEXT COLOR

RTD TEMPERATURE

RTD TYPES

Stator RTD Type	10 Ohm Copper
Bearing RTD Type	10 Ohm Copper
Ambient RTD Type	10 Ohm Copper
Other RTD Type	10 Ohm Copper

RTD #1

RTD #1 Application	Stator
RTD #1 Name	Stator#1
RTD #1 Alarm	Unlatched
RTD #1 Alarm Relays	Alarm
RTD #1 Alarm Temperature	115 °C
RTD #1 Trip	Latched
RTD #1 Trip Voting	RTD #1
RTD #1 Trip Relays	Trip
RTD #1 Trip Temperature	115 °C
RTD #1 Hi Alarm	Unlatched
RTD #1 Hi Alarm Relays	Alarm
RTD #1 Hi Alarm Level	120 °C

RTD #2

RTD #2 Application	Stator
RTD #2 Name	

RTD #3

RTD #3 Application	Stator
RTD #3 Name	

RTD #4

RTD #4 Application	Stator
RTD #4 Name	

RTD #5

RTD #5 Application	Stator
RTD #5 Name	

RTD #6

RTD #6 Application	Stator
RTD #6 Name	

RTD #7

RTD #7 Application	Bearing
RTD #7 Name	

RTD #8

RTD #8 Application	Bearing
RTD #8 Name	

RTD #9

RTD #9 Application	Bearing
RTD #9 Name	

RTD #10

RTD #10 Application	Bearing
RTD #10 Name	

RTD #11

RTD #11 Application	Other
RTD #11 Name	

RTD #12

RTD #12 Application	Ambient
RTD #12 Name	

ALARMS

Open RTD Sensor Alarm	Latched
Open RTD Sensor Alarm Relays	Alarm
RTD Short/Low Temp Alarm	Latched
RTD Short/Low Temp. Alarm Relays	Alarm

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.6X
SERIAL NUMBER: A3000360
DESCRIPTION: (NONE)
TEXT COLOR

VOLTAGE ELEMENTS

UNDERVOLTAGE

Undervoltage Active Only If Bus Energized	On/Yes
Undervoltage Trip	Unlatched
Undervoltage Trip Relays	Trip
Undervoltage Trip Pickup	0.75 Rated
Starting Undervoltage Trip Pickup	0.75 Rated
Undervoltage Trip Delay	4.0 s

PHASE REVERSAL

Voltage Phase Reversal Trip	Latched
Voltage Phase Reversal Trip Relays	Trip

POWER ELEMENTS

POWER FACTOR

Block Power Factor Element from Start	1 s

REACTIVE POWER

Block kvar Element from Start	1 s

UNDERPOWER

Block Underpower From Start	0 s

REVERSE POWER

Block Reverse Power From Start	0 s

TORQUE SETUP

Stator Resistance	0.004 mOhm
Pole Pairs	2
Torque Unit	Newton-meter

OVERTORQUE SETUP

Overtorque Alarm Relays	Alarm
Overtorque Alarm Level	4000.0 Nm
Overtorque Alarm Delay	1.0 s

STARTER FAILURE

Starter Failure Alarm (Starter Failure)	Latched
Starter Type	Contactor
Starter Failure Alarm Relays	Alarm
Starter Failure Alarm Delay	500 ms

CURRENT DEMAND

Current Demand Period	15 min

KW DEMAND

kW Demand Period	15 min

KVAR DEMAND

kvar Demand Period	15 min

KVA DEMAND

kVA Demand Period	15 min

PULSE OUTPUT

Positive kWh Pulse Output Relay	Auxiliary2
Positive kWh Pulse Output Interval	100 kWh
Running Time Pulse Relay	Auxiliary2
Running Time Pulse Interval	1 sec

ANALOG I/O

ANALOG INPUT 1

Analog Input 1 Setup	4-20 mA
Analog Input 1 Name	Analog I/P 1
Analog Input 1 Units	Units
Analog Input 1 Maximum (analog in 1)	1000
Block Analog Input 1 From Start	0 s

ANALOG INPUT 2

Analog Input 2 Setup	4-20 mA

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.6X
SERIAL NUMBER: A3000360
DESCRIPTION: (NONE)
TEXT COLOR

ANALOG INPUT 2 (continued from last page)

Analog Input 2 Name	Analog I/P 2
Analog Input 2 Units	Units
Analog Input 2 Maximum (analog in 2)	1000
Block Analog Input 2 From Start	0 s

ANALOG INPUT 3

Analog Input 3 Setup	4-20 mA
Analog Input 3 Name	Analog I/P 3
Analog Input 3 Units	Units
Analog Input 3 Maximum (analog in 3)	1000
Block Analog Input 3 From Start	0 s

ANALOG INPUT 4

Analog Input 4 Setup	4-20 mA
Analog Input 4 Name	Analog I/P 4
Analog Input 4 Units	Units
Analog Input 4 Maximum (analog in 4)	1000
Block Analog Input 4 From Start	0 s

ANALOG OUTPUTS

Analog Output 1 Selection	None
Analog Output 2 Selection	None
Analog Output 3 Selection	None
Analog Output 4 Selection	None

O2_COMP_2_1_469.469
D:
DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

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469 SETUP

PREFERENCES

Default Message Cycle Time	2.0 s
Default Message Timeout	300 s
Average Motor Load Calculation Period	15 min
Temperature Display Units	Celsius
Trace Memory Trigger Position	25 %
Trace Memory Buffers	8 x 28 cycles
Display Update Interval	0.4 s
Motor Load Filter Interval	0 cycles

MESSAGE SCRATCHPAD

First Scratchpad Message	
Second Scratchpad Message	
Third Scratchpad Message	
Fourth Scratchpad Message	
Fifth Scratchpad Message	

COMMUNICATION

Ethernet IP Address	0. 0. 0. 0
Ethernet Subnet Mask	255.255.255. 0
Ethernet Gateway Address	0. 0. 0. 0
DeviceNet MAC ID	1
DeviceNet Baud Rate	125 kbps
Front RS232 baud rate	19200 baud
Slave Address	254
Computer RS485 Baud Rate	9600 baud
Computer RS485 Parity	None
Auxiliary RS485 Baud Rate	9600 baud
Auxiliary RS485 Parity	None

SYSTEM SETUP

CURRENT SENSING

Phase CT Primary	OFF
Motor Full Load Amps	OFF
Ground CT Type	Multlin CT 50/0.025
Phase Differential CT Type	None
Enable Two Speed Motor Option	Off/No

VOLTAGE SENSING

VoltageTransformer Connection Type	None

POWER SYSTEM

Nominal System Frequency	60 Hz
System Phase Sequence	ABC

SERIAL COMM CONTROL

Serial Communication Control	Off/No

REDUCED VOLTAGE

Reduced Voltage Starting	Off/No

DIGITAL INPUTS

STARTER

Starter Status Switch	Start Aux a

INPUT 1

Assignable Input 1 Function	Off

INPUT 2

Assignable Input 2 Function	Off

INPUT 3

Assignable Input 3 Function	Off

INPUT 4

Assignable Input 4 Function	Off

OUTPUT RELAYS

TRIP RELAY

Reset Mode R1 Trip	All Resets

O2_COMP_2_1_469.469
D:
DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

TRIP RELAY (continued from last page)

Force R1 Output Relay	Disabled
Force R1 Operate Time	0 s

ALARM RELAY

Reset Mode R4 Auxiliary	All Resets
Force R4 Output Relay	Disabled
Force R4 Operate Time	0 s

AUX RELAY 2

Reset Mode R2 Auxiliary	All Resets
Force R2 Output Relay	Disabled
Force R2 Output Operate Time	0 s

AUX RELAY 3

Reset Mode R3 Auxiliary	All Resets
Force R3 Output Relay	Disabled
Force R3 Operate Time	0 s

BLOCK START RELAY

Force R5 Output Relay	Disabled
Force R5 Operate Time	0 s

SERVICE RELAY

Reset Mode R6 Service	All Resets

PROTECTION
THERMAL MODEL
469 THERMAL MODEL

Curve Style	Standard
Overload Pickup Level	1.01 FLA
Unbalance k Factor	0
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	1.00
RTD Biasing	Off/No
Thermal Capacity Alarm	Off
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	Off/No
Overload Trip Relays	Trip

OVERLOAD CURVE

Standard Overload Curve Number	4

CURRENT ELEMENTS
SHORT CIRCUIT TRIP

Short Circuit Trip	Off
Short Circuit Trip Backup	Off/No

OVERLOAD ALARM

Overload Alarm	Off

MECHANICAL JAM

Mechanical Jam Trip	Off

UNDERCURRENT

Block Undercurrent from Start	0 s
Undercurrent Alarm	Off
Undercurrent Trip	Off

CURRENT UNBALANCE

Current Unbalance Alarm	Off
Current Unbalance Trip	Off

GROUND FAULT

Ground Fault Alarm	Off
Ground Fault Alarm Events	Off/No
Ground Fault Trip	Off
Ground Fault Trip Backup	Off/No
Ground Fault Overreach Filter	Off/No

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

PHASE DIFFERENTIAL	
Phase Differential Trip	Off
MOTOR STARTING	
ACCELERATION TIMER	
Accleration Timer Trip	Off
START INHIBIT	
Start Inhibit Block	Off/No
JOGGING BLOCK	
Jogging Block	Off/No
RESTART BLOCK	
Restart Block	Off/No
RTD TEMPERATURE	
RTD TYPES	
Stator RTD Type	100 Ohm Platinum
Bearing RTD Type	100 Ohm Platinum
Ambient RTD Type	100 Ohm Platinum
Other RTD Type	100 Ohm Platinum
RTD #1	
RTD #1 Application	None
RTD #2	
RTD #2 Application	Stator
RTD #2 Name	
RTD #2 Alarm	Off
RTD #2 Trip	Off
RTD #2 Hi Alarm	Off
RTD #3	
RTD #3 Application	Stator
RTD #3 Name	
RTD #3 Alarm	Off
RTD #3 Trip	Off
RTD #3 Hi Alarm	Off
RTD #4	
RTD #4 Application	None
RTD #5	
RTD #5 Application	Stator
RTD #5 Name	
RTD #5 Alarm	Off
RTD #5 Trip	Off
RTD #5 Hi Alarm	Off
RTD #6	
RTD #6 Application	Stator
RTD #6 Name	
RTD #6 Alarm	Off
RTD #6 Trip	Off
RTD #6 Hi Alarm	Off
RTD #7	
RTD #7 Application	Bearing
RTD #7 Name	
RTD #7 Alarm	Off
RTD #7 Trip	Off
RTD #7 Hi Alarm	Off
RTD #8	
RTD #8 Application	Bearing
RTD #8 Name	
RTD #8 Alarm	Off
RTD #8 Trip	Off
RTD #8 Hi Alarm	Off

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D:
DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

RTD #9	
RTD #9 Application	Bearing
RTD #9 Name	
RTD #9 Alarm	Off
RTD #9 Trip	Off
RTD #9 Hi Alarm	Off
RTD #10	
RTD #10 Application	Bearing
RTD #10 Name	
RTD #10 Alarm	Off
RTD #10 Trip	Off
RTD #10 Hi Alarm	Off
RTD #11	
RTD #11 Application	Other
RTD #11 Name	
RTD #11 Alarm	Off
RTD #11 Trip	Off
RTD #11 Hi Alarm	Off
RTD #12	
RTD #12 Application	Ambient
RTD #12 Name	
RTD #12 Alarm	Off
RTD #12 Trip	Off
RTD #12 Hi Alarm	Off
ALARMS	
Open RTD Sensor Alarm	Off
RTD Short/Low Temp Alarm	Off
VOLTAGE ELEMENTS	
UNDERVOLTAGE	
Undervoltage Active Only If Bus Energized	Off/No
Undervoltage Alarm	Off
Undervoltage Trip	Off
OVERVOLTAGE	
Overvoltage Alarm	Off
Overvoltage Trip	Off
PHASE REVERSAL	
Voltage Phase Reversal Trip	Off
FREQUENCY	
Voltage Frequency Alarm	Off
Voltage Frequency Trip	Off
POWER ELEMENTS	
POWER FACTOR	
Block Power Factor Element from Start	1 s
Power Factor Alarm	Off
Power Factor Trip	Off
REACTIVE POWER	
Block kvar Element from Start	1 s
Reactive Power Alarm	Off
Reactive Power Trip	Off
UNDERPOWER	
Block Underpower From Start	0 s
Underpower Alarm	Off
Underpower Trip	Off
REVERSE POWER	
Block Reverse Power From Start	0 s
Reverse Power Alarm	Off
Reverse Power Trip	Off

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

TORQUE SETUP

Torque Metering	Disabled
Stator Resistance	0.004 mOhm
Pole Pairs	2
Torque Unit	Newton-meter

OVERTORQUE SETUP

Overtorque Alarm	Off
Overtorque Alarm Relays	Alarm
Overtorque Alarm Level	4000.0 Nm
Overtorque Alarm Delay	1.0 s
Overtorque Alarm Events	Off/No

MONITORING

TRIP COUNTER

Trip Counter Alarm	Off

STARTER FAILURE

Starter Failure Alarm (Starter Failure)	Off

CURRENT DEMAND

Current Demand Period	15 min
Current Demand Alarm	Off

KW DEMAND

kW Demand Period	15 min
kW Demand Alarm	Off

KVAR DEMAND

kvar Demand Period	15 min
kvar Demand Alarm	Off

KVA DEMAND

kVA Demand Period	15 min
kVA Demand Alarm	Off

PULSE OUTPUT

Positive kWh Pulse Output Relay	Off
Positive kvarh Pulse Output Relay	Off
Negative kvarh Pulse Output Relay	Off
Running Time Pulse Relay	Off

LOSS OF COMMS

Loss Of Comms Function	Off
Loss Of Comms Function Type	Alarm
Loss Of Comms Port	COMP_RS485
Assign Loss Of Comms Alarm Relay	Alarm
Assign Loss Of Comms Trip Relay	Trip
Loss Of Comms Delay	1 s
Loss Of Comms Alarm Event	Off/No

ANALOG I/O

ANALOG INPUT 1

Analog Input 1 Setup	Disabled

ANALOG INPUT 2

Analog Input 2 Setup	Disabled

ANALOG INPUT 3

Analog Input 3 Setup	Disabled

ANALOG INPUT 4

Analog Input 4 Setup	Disabled

ANALOG OUTPUTS

Analog Output 1 Selection	None
Analog Output 2 Selection	None
Analog Output 3 Selection	None
Analog Output 4 Selection	None

469 TESTING

O2_COMP_2_1_469.469
D:
DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

SIMULATION MODE

Simulation Mode	Off
Pre-Fault to Fault Time Delay	15 s

PRE-FAULT SETUP

Pre-Fault Current Phase A	0.00 xCT
Pre-Fault Current Phase B	0.00 xCT
Pre-Fault Current Phase C	0.00 xCT
Pre-Fault Ground Current	0.0 A
Pre-Fault Line Voltages	1.00 Rated
Pre-Fault Current Lags Voltage	0 °
Stator RTD Pre-Fault Temperature	40 °C
Bearing RTD Pre-Fault Temperature	40 °C
Other RTD Pre-Fault Temperature	40 °C
Ambient RTD Pre-Fault Temperature	40 °C
Pre-Fault System Frequency	60.0 Hz
Pre-Fault Analog Input 1	0 % range
Pre-Fault Analog Input 2	0 % range
Pre-Fault Analog Input 3	0 % range
Pre-Fault Analog Input 4	0 % range
Pre-Fault Differential Current	0.00 xCT
Pre-Fault Stator RTD Temperature (in Fahr.)	104 °F
Pre-Fault Bearing RTD Temperature (in Fahr.)	104 °F
Pre-Fault Other RTD Temperature (in Fahr.)	104 °F
Pre-Fault Ambient RTD Temperature (in Fahr.)	104 °F

FAULT SETUP

Fault Current Phase A	0.00 xCT
Fault Current Phase B	0.00 xCT
Fault Current Phase C	0.00 xCT
Fault Ground Current	0.0 A
Fault Line Voltage	1.00 Rated
Fault Current Lags Voltage	0 °
Stator RTD Fault Temperature	40 °C
Bearing RTD Fault Temperature	40 °C
Other RTD Fault Temperature	40 °C
Ambient RTD Fault Temperature	40 °C
Fault System Frequency	60.0 Hz
Fault Analog Input 1	0 % range
Fault Analog Input 2	0 % range
Fault Analog Input 3	0 % range
Fault Analog Input 4	0 % range
Fault Differential Current	0.00 xCT
Fault Stator RTD Temperature (in Fahrenheit)	104 °F
Fault Bearing RTD Temperature (in Fahrenheit)	104 °F
Fault Other RTD Temperature (in Fahrenheit)	104 °F
Fault Ambient RTD Temperature (in Fahrenheit)	104 °F

TEST OUTPUT RELAYS

Force Operation of Relays	Disabled

TEST ANALOG OUTPUTS

Force Analog Outputs	Disabled
Analog Output 1 Forced Value	0 % range
Analog Output 2 Forced Value	0 % range
Analog Output 3 Forced Value	0 % range
Analog Output 4 Forced Value	0 % range

TWO SPEED MOTOR

SPEED 2 OVERLOAD

Speed2 Standard Overload Curve Number	4
Speed2 Time to Trip at 1.01 x FLA	17414.5 s
Speed2 Time to Trip at 1.05 x FLA	3414.9 s
Speed2 Time to Trip at 1.10 x FLA	1666.7 s
Speed2 Time to Trip at 1.20 x FLA	795.4 s
Speed2 Time to Trip at 1.30 x FLA	507.2 s
Speed2 Time to Trip at 1.40 x FLA	364.6 s
Speed2 Time to Trip at 1.50 x FLA	280.0 s
Speed2 Time to Trip at 1.75 x FLA	169.7 s
Speed2 Time to Trip at 2.00 x FLA	116.6 s
Speed2 Time to Trip at 2.25 x FLA	86.1 s

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 5.2X
SERIAL NUMBER: (NONE)
DESCRIPTION: (NONE)
TEXT COLOR

SPEED 2 OVERLOAD (continued from last page)

Speed2 Time to Trip at 2.50 x FLA	66.6 s
Speed2 Time to Trip at 2.75 x FLA	53.3 s
Speed2 Time to Trip at 3.00 x FLA	43.7 s
Speed2 Time to Trip at 3.25 x FLA	36.6 s
Speed2 Time to Trip at 3.50 x FLA	31.1 s
Speed2 Time to Trip at 3.75 x FLA	26.8 s
Speed2 Time to Trip at 4.00 x FLA	23.3 s
Speed2 Time to Trip at 4.25 x FLA	20.5 s
Speed2 Time to Trip at 4.50 x FLA	18.2 s
Speed2 Time to Trip at 4.75 x FLA	16.2 s
Speed2 Time to Trip at 5.00 x FLA	14.6 s
Speed2 Time to Trip at 5.50 x FLA	12.0 s
Speed2 Time to Trip at 6.00 x FLA	10.0 s
Speed2 Time to Trip at 6.50 x FLA	8.5 s
Speed2 Time to Trip at 7.00 x FLA	7.3 s
Speed2 Time to Trip at 7.50 x FLA	6.3 s
Speed2 Time to Trip at 8.00 x FLA	5.6 s
Speed2 Time to Trip at 10.0 x FLA	5.6 s
Speed2 Time to Trip at 15.0 x FLA	5.6 s
Speed2 Time to Trip at 20.0 x FLA	5.6 s
Speed2 Minimum Allowable Line Voltage	80 % Rated
Speed2 Stall Current at Min Vline	4.80 FLA
Speed2 Safe Stall Time at Min Vline	20.0 s
Speed2 Accel. Intersect at Min Vline	3.80 FLA
Speed2 Stall Current at 100% Vline	6.00 FLA
Speed2 Safe Stall Time at 100% Vline	10.0 s
Speed2 Accel. Intersect at 100% Vline	5.00 FLA

SPEED 2 UNDERCURRENT

Block Speed2 Undercurrent from Start	0 s
Speed2 Undercurrent Alarm	Off
Speed2 Undercurrent Alarm Pickup	0.70 FLA
Speed2 Undercurrent Alarm Delay	1 s
Speed2 Undercurrent Alarm Events	Off/No
Speed2 Undercurrent Trip	Off
Speed2 Undercurrent Trip Pickup	0.70 FLA
Speed2 Undercurrent Trip Delay	1 s

SPEED 2 ACCELERATION

Speed2 Acceleration Timer From Start	10.0 s
Acceleration Timer From Speed One to Two	10.0 s
Speed Switch Trip Speed2 Delay	5.0 s
Speed2 Rated Speed	3600 R.P.M

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.8X
SERIAL NUMBER: A3022801
DESCRIPTION: (NONE)
TEXT COLOR

469 SETUP

PREFERENCES

Default Message Cycle Time	2.0 s
Default Message Timeout	300 s
Average Motor Load Calculation Period	15 min
Temperature Display Units	Celsius
Trace Memory Trigger Position	25 %
Trace Memory Buffers	8 x 14 cycles
Display Update Interval	0.4 s
Motor Load Filter Interval	0 cycles

MESSAGE SCRATCHPAD

First Scratchpad Message	Text 1
Second Scratchpad Message	Text 2
Third Scratchpad Message	Text 3
Fourth Scratchpad Message	Text 4
Fifth Scratchpad Message	MULTILIN SR469 Motor Management Relay

SYSTEM SETUP

CURRENT SENSING

Phase CT Primary	200 A
Motor Full Load Amps	145 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A

VOLTAGE SENSING

VoltageTransformer Connection Type	Open Delta
Voltage Transformer Ratio	35.00 :1
Motor Nameplate Voltage	4160 V

POWER SYSTEM

Nominal System Frequency	60 Hz
System Phase Sequence	ABC

REDUCED VOLTAGE

Reduced Voltage Starting	On/Yes
Control Relays for Reduced Voltage Starting	Auxiliary 3
Transition On	Current and Timer
Reduced Voltage Start Level	300 % FLA
Reduced Voltage Start Timer	10 s
Incomplete Sequence Trip Relays	Trip

DIGITAL INPUTS

STARTER

Starter Status Switch	Start Aux a

INPUT 1

Assignable Input 1 Function	General Sw. A
General Switch A Name	Incomplet SQ
General Switch A Normal State	Normally Open
General Switch A Block Input From Start	0 s
General Switch A Alarm Relays	Alarm
General Switch A Alarm Delay	5.0 s
General Switch A Trip	Latched
General Switch A Trip Relays	Trip
General Switch A Trip Delay	12.0 s

OUTPUT RELAYS

TRIP RELAY

Force R1 Operate Time	0 s

ALARM RELAY

Force R4 Operate Time	0 s

AUX RELAY 2

Force R2 Output Operate Time	0 s

AUX RELAY 3

Force R3 Operate Time	0 s

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.8X
SERIAL NUMBER: A3022801
DESCRIPTION: (NONE)
TEXT COLOR

BLOCK START RELAY

Force R5 Operate Time	0 s

PROTECTION
THERMAL MODEL
469 THERMAL MODEL

Curve Style	Standard
Overload Pickup Level	1.17 FLA
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	1.00
Thermal Capacity Alarm	Unlatched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Overload Trip Relays	Trip

OVERLOAD CURVE

Standard Overload Curve Number	4

OVERLOAD ALARM

Overload Alarm	Unlatched
Overload Alarm Relays	Alarm
Overload Alarm Delay	60.0 s

MECHANICAL JAM

Mechanical Jam Trip	Latched
Mechanical Jam Trip Relays	Trip
Mechanical Jam Pickup	1.50 xFLA
Mechanical Jam Delay	1 s

UNDERCURRENT

Block Undercurrent from Start	0 s

CURRENT UNBALANCE

Current Unbalance Alarm	Unlatched
Current Unbalance Alarm Relays	Alarm
Current Unbalance Alarm Pickup	15 %
Current Unbalance Alarm Delay	1 s
Current Unbalance Trip	Latched
Current Unbalance Trip Relays	Trip
Current Unbalance Trip Pickup	20 %
Current Unbalance Trip Delay	1 s

GROUND FAULT

Ground Fault Alarm	Unlatched
Ground Fault Alarm Relays	Alarm
Ground Fault Alarm Pickup	0.50 CT
Intentional GF Alarm Delay	10 ms
Ground Fault Trip	Latched
Ground Fault Trip Relays	Trip
Ground Fault Trip Pickup	1.00 CT
Intentional GF Trip Delay	150 ms

PHASE DIFFERENTIAL

Phase Differential Trip	Latched
Phase Differential Trip Relays	Trip
Differential Trip Pickup While Starting	0.10 CT
Differential Trip Delay While Starting	0 ms
Differential Trip Pickup While Running	0.10 CT
Differential Trip Delay While Running	0 ms

JOGGING BLOCK

Jogging Block	On/Yes
Maximum Starts/Hour Permissible	2
Time Between Starts	15 min

RTD TEMPERATURE
RTD TYPES

Stator RTD Type	10 Ohm Copper
Bearing RTD Type	10 Ohm Copper

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.8X
SERIAL NUMBER: A3022801
DESCRIPTION: (NONE)
TEXT COLOR

RTD TYPES (continued from last page)

Ambient RTD Type	10 Ohm Copper
Other RTD Type	10 Ohm Copper

RTD #1

RTD #1 Application	Stator
RTD #1 Name	Stator#1
RTD #1 Alarm	Unlatched
RTD #1 Alarm Relays	Alarm
RTD #1 Alarm Temperature	115 °C
RTD #1 Trip	Latched
RTD #1 Trip Voting	RTD #1
RTD #1 Trip Relays	Trip
RTD #1 Trip Temperature	125 °C
RTD #1 Hi Alarm	Unlatched
RTD #1 Hi Alarm Relays	Alarm
RTD #1 Hi Alarm Level	120 °C

RTD #2

RTD #2 Application	Stator
RTD #2 Name	

RTD #3

RTD #3 Application	Stator
RTD #3 Name	

RTD #4

RTD #4 Application	Stator
RTD #4 Name	

RTD #5

RTD #5 Application	Stator
RTD #5 Name	

RTD #6

RTD #6 Application	Stator
RTD #6 Name	

RTD #7

RTD #7 Application	Bearing
RTD #7 Name	

RTD #8

RTD #8 Application	Bearing
RTD #8 Name	

RTD #9

RTD #9 Application	Bearing
RTD #9 Name	

RTD #10

RTD #10 Application	Bearing
RTD #10 Name	

RTD #11

RTD #11 Application	Other
RTD #11 Name	

RTD #12

RTD #12 Application	Ambient
RTD #12 Name	

ALARMS

Open RTD Sensor Alarm	Latched
Open RTD Sensor Alarm Relays	Alarm
RTD Short/Low Temp Alarm	Latched
RTD Short/Low Temp. Alarm Relays	Alarm

VOLTAGE ELEMENTS
UNDERVOLTAGE

Undervoltage Active Only If Bus Energized	On/Yes

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.8X
SERIAL NUMBER: A3022801
DESCRIPTION: (NONE)
TEXT COLOR

UNDERVOLTAGE (continued from last page)

Undervoltage Trip	Unlatched
Undervoltage Trip Relays	Trip
Undervoltage Trip Pickup	0.75 Rated
Starting Undervoltage Trip Pickup	0.75 Rated
Undervoltage Trip Delay	4.0 s

PHASE REVERSAL

Voltage Phase Reversal Trip	Latched
Voltage Phase Reversal Trip Relays	Trip

POWER ELEMENTS

POWER FACTOR

Block Power Factor Element from Start	1 s

REACTIVE POWER

Block kvar Element from Start	1 s

UNDERPOWER

Block Underpower From Start	0 s

REVERSE POWER

Block Reverse Power From Start	0 s

TORQUE SETUP

Stator Resistance	0.004 mOhm
Pole Pairs	2
Torque Unit	Newton-meter

OVERTORQUE SETUP

Overtorque Alarm Relays	Alarm
Overtorque Alarm Level	4000.0 Nm
Overtorque Alarm Delay	1.0 s

STARTER FAILURE

Starter Failure Alarm (Starter Failure)	Latched
Starter Type	Contactor
Starter Failure Alarm Relays	Alarm
Starter Failure Alarm Delay	500 ms

CURRENT DEMAND

Current Demand Period	15 min

KW DEMAND

kW Demand Period	15 min

KVAR DEMAND

kvar Demand Period	15 min

KVA DEMAND

kVA Demand Period	15 min

PULSE OUTPUT

Positive kWh Pulse Output Relay	Auxiliary2
Positive kWh Pulse Output Interval	100 kWh
Running Time Pulse Relay	Auxiliary2
Running Time Pulse Interval	1 sec

ANALOG I/O

ANALOG INPUT 1

Analog Input 1 Setup	4-20 mA
Analog Input 1 Name	Analog I/P 1
Analog Input 1 Units	Units
Analog Input 1 Maximum (analog in 1)	1000
Block Analog Input 1 From Start	0 s

ANALOG INPUT 2

Analog Input 2 Setup	4-20 mA
Analog Input 2 Name	Analog I/P 2
Analog Input 2 Units	Units
Analog Input 2 Maximum (analog in 2)	1000

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DEVICE DEFINITION
ORDER CODE: 469
VERSION: 2.8X
SERIAL NUMBER: A3022801
DESCRIPTION: (NONE)
TEXT COLOR

ANALOG INPUT 2 (continued from last page)	
Block Analog Input 2 From Start	0 s

ANALOG INPUT 3	
Analog Input 3 Setup	4-20 mA
Analog Input 3 Name	Analog I/P 3
Analog Input 3 Units	Units
Analog Input 3 Maximum (analog in 3)	1000
Block Analog Input 3 From Start	0 s

ANALOG INPUT 4	
Analog Input 4 Setup	4-20 mA
Analog Input 4 Name	Analog I/P 4
Analog Input 4 Units	Units
Analog Input 4 Maximum (analog in 4)	1000
Block Analog Input 4 From Start	0 s

ANALOG OUTPUTS	
Analog Output 1 Selection	None
Analog Output 2 Selection	None
Analog Output 3 Selection	None
Analog Output 4 Selection	None

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included.

1. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the drawings and as specified herein.

B. Related sections

1. Section 01 33 00 – Submittal Procedures
2. Section 26 05 00 - Common Work Results for Electrical
3. Section 26 05 53 - Identification for Electrical Systems
4. Section 26 08 00 - Commissioning of Electrical Systems

C. Related work

1. Panelboard schedules are shown on the drawings.

1.2 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01 33 00.

B. In addition to the requirements of Section 01 33 00, the Contractor shall furnish submittals for approval as outlined below:

1. Submit panelboard schedules for each panelboard showing circuit allocations, breaker rating, spare, short-circuit and bus ratings.
2. Outline drawings showing dimensions.
3. Wiring diagrams.

1.3 DELIVERY, STORAGE AND HANDLING

A. Refer to Common Work Results for Electrical, Section 26 05 00.

1.4 REFERENCE STANDARDS

A. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

1.5 JOB CONDITIONS

A. Refer to Common Work Results for Electrical, Section 26 05 00.

PART 2 - PRODUCTS

2.1 GENERAL

A. Panelboards shall include the number of circuit breakers and amperage as shown on the panelboard schedules included in the drawings.

2.2 PANELBOARDS

A. Rating

1. Panelboard ratings shall be as shown on the drawings. All panelboards shall be rated for the intended voltage.

2. Panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

3. Enclosure rating shall be NEMA Type 1 gasketed, unless noted otherwise on the drawings.

B. Construction

1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.

2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

5. Construction of panel shall be door-in-door type.

C. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.

4. Provide equipment ground bars.

D. Boxes

1. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.

2. Surface mounted boxes and trims shall have an internal and external finish as hereinafter specified below. Surface mounted boxes shall be field punched for conduit entrances.

3. Provide at least 4 studs for mounting the panelboard interior.

E. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.

2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

3. The trims shall be fabricated from code gauge sheet steel.

4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a

rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.

5. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

F. Acceptable Manufactures:

1. Cutler-Hammer, Pow-R-Line C

2. ABB

3. Or equal.

2.3 COMPONENTS

A. Equip panelboards with circuit breakers with frame size and trip settings as shown on the drawings.

B. Circuit breakers shall be molded case, bolt-in type. Handle ties are not acceptable.

C. Circuit breakers shall have an interrupting capacity of not less than 10,000 amperes RMS symmetrical.

D. Circuit breakers shall be as manufactured by the panelboard manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses.

C. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.

D. Install markers on the front cover of all panelboards which identify the voltage and phase rating. Markers shall be made of self-sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal as approved by the Engineer.

3.2 FIELD QUALITY CONTROL

A. Acceptance testing of the panelboard shall be per the requirements of Section 26 08 00.

END OF SECTION

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