

STATE OF CALIFORNIA DEPARTMENT OF GENERAL SERVICES REAL ESTATE SERVICES DIVISION PROJECT MANAGEMENT & DEVELOPMENT BRANCH

# PROJECT MANUAL – Book II of III

INTRODUCTORY INFORMATION SPECIFICATIONS

FOR:

# DSH-ATASCADERO RE-ROOF, HVAC REPLACEMENT & ELECTRICAL UPGRADES

# **DEPARTMENT OF STATE HOSPITALS**

# ATASCADERO, SAN LUIS OBISPO COUNTY, CALIFORNIA

Matt Davidson, Project Director West Sacramento, California

### DOCUMENT 00 01 01

### **PROJECT TITLE PAGE**

Title:	CALIFORNIA DEPARTMENT OF STATE HOSPITALS DSH-ATASCADERO RE-ROOF, HVAC REPLACEMENT & ELECTRICAL UPGRADES
Client Agency:	DEPARTMENT OF GENERAL SERVICES REAL ESTATE SERVICES DIVISION PROJECT MANAGEMENT & DEVELOPMENT BRANCH
Location:	ATASCADERO, SAN LUIS OBISPO COUNTY, CALIFORNIA
Project Number:	DGS00000142452
Project Director:	Matt Davidson State of California Department of General Services Real Estate Services Division Project Management and Development Branch 707 Third Street, 4 <sup>th</sup> Floor West Sacramento, California 95605 Telephone Number: (916) 708-0576 Email: <u>Matt.Davidson@dgs.ca.gov</u>
Consultant:	Scott Pullen HMR Architects 2130 21st Street Sacramento, CA 95818 Telephone Number: 916-736-2724 Email: <u>Scottp@hmrarchitects.com</u>
Construction Manager:	David Dunstan APSI Construction Management 8885 Research Drive Irvine, CA 92618 Telephone Number: 916-736-2724 Email: <u>David.Dunstan@apsicm.com</u>

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### CERTIFICATIONS PAGE

PROJECT TITLE:	California Department of State Hospitals, DSH – Atascadero Reroof and HVAC Replacement
CLIENT AGENCY:	Department of General Services – Real Estate Services Division, Project Management & Development Branch
LOCATION:	10333 El Camino Real Atascadero, San Luis Obispo County, California
PROJECT NUMBER:	DGS00000142452
OWNER:	State of California
A/E CONSULTANT:	Scott Pullen HMR Architects 2130 21 <sup>st</sup> Street Sacramento, CA 95818 Telephone Number: (916) 736-2724





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### TOTAL QUANTITY OF SHEETS = 425 FOR SFM PERMIT #22-S-3319 FOR MAIN FACILITY OSFM #19-40-11-0001-00001

### PERMIT #22-S-4869 – FIREHOUSE

Sheet Number	Description
A0 CG1-R CG2-R <u>AS1</u> SHEETS	COVER SHEET CALGREEN MANDATORY MEASURES CHECKLIST CALGREEN MANDATORY MEASURES CHECKLIST <u>REFERENCE SITE PLAN</u> 4
AD1.0 AD1.23 A1.0 A1.23 A2.0 A2.1 A2.2 A2.3 A2.4 A2.5 A2.6 A2.7 SHEETS	ARCHITECTURAL OVERALL DEMO ROOF PLAN DEMO ROOF PLAN - STEAM PLANT OVERALL ROOF PLAN ROOF PLAN - STEAM PLANT DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS JETAILS DETAILS 12
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### **MECHANICAL**

	M1.23	ENLARGED DEMO MECH ROOF PLAN MAINTENANCE SHOP
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M2.23 NEW ROOF PLAN MAINTENANCE SHOPS 2

SHEETS

### TOTAL QUANTITY OF SHEETS = 18 FOR SFM PERMIT #22-S-4869 FOR FIREHOUSE OSFM #19-40-61-0001-00041

### PERMIT #22-S-4870 – STEAM PLANT

Sheet Number	Description
A0 CG1-R CG2-R <u>AS1</u> SHEETS	COVER SHEET CALGREEN MANDATORY MEASURES CHECKLIST CALGREEN MANDATORY MEASURES CHECKLIST <u>REFERENCE SITE PLAN</u> 4
AD1.0 AD1.24 A1.0 A1.24 A2.0 A2.1 A2.2 A2.3 A2.4 A2.5 A2.6	ARCHITECTURAL OVERALL DEMO ROOF PLAN DEMO ROOF PLAN - STEAM PLANT OVERALL ROOF PLAN ROOF PLAN - STEAM PLANT DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS DETAILS
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TOTAL QUANTITY OF SHEETS = 16 FOR SFM PERMIT #22-S-4870 FOR STEAM PLANT OSFM #19-40-27-0001-00032

### PERMIT #22-S-4872 - ELECTRICAL UPGRADE

Sheet	Description
Number	

A0	COVER SHEET
CG1-E	CALGREEN MANDATORY MEASURES CHECKLIST
CG2-E	CALGREEN MANDATORY MEASURES CHECKLIST
AS1	REFERENCE SITE PLAN
ADE1	ELECTRICAL UPGRADE SITE DEMOLITION PLAN
ASE1	ELECTRICAL UPGRADE SITE PLAN
ASE2	ELECTRICAL UPGRADE ENLARGED SITE PLANS
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SHEETS

### **CIVIL TOPO SURVEY**

VU-1.0	TITLE SHEET
VU-1.1	SHEET 2
VU-1.2	SHEET 3
VU-1.3	SHEET 4
VU-1.4	SHEET 5
VU-1.5	SHEET 6
<u>VU-1.6</u>	SHEET 7
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SHEETS

### **ELECTRICAL UPGRADE**

- C-1.1 COVER SHEET
- C-1.2 NOTES SHEET
- C-1.3 PROJECT CONTROL PLAN
- C-2.1 **OVERALL GRADING PLAN**
- C-2.2 **GRADING PLAN**
- C-2.3 **GRADING PLAN**
- C-3.1 UTILITY PLAN
- CONSTRUCTION DETAILS C-4.1
- C-4.2 CONSTRUCTION DETAILS
- AE1 SWITCHGEAR BUILDING PLANS
- AE2 SWITCHGEAR BUILDING SECTION & ELEVATIONS
- SWITCHGEAR BUILDING DETAILS AE3
- SE0.00 **GENERAL NOTES**
- SE0.01 STRUCTURAL SPECIAL INSPECTIONS & TESTING
- SE0.02 STRUCTURAL SPECIAL INSPECTIONS & TESTING
- SE1.01 SWITCHGEAR BUILDING PLANS
- SE3.00 SWITCHGEAR BUILDING SECTIONS
- SE4.00 **ELEVATIONS**
- SE5.01 SWITCHGEAR BUILDING SECTIONS & DETAILS
- SE5.02 **TYPICAL CMU DETAILS**
- SE5.03 **TYPICAL STEEL DETAILS**
- SE5.04 EQUIPMENT ANCHORAGE DETAILS

#### MECHANICAL PLUMBING LEGENDS, NOTES & SCHEDULES MPE0.1

- MPE1 MECHANICAL PLUMBING GENERATOR YARD FLOOR PLAN
- MPE2 **MECHANICAL PLUMBING PIPING P&ID & SCHEMATICS**
- MECHANICAL PLUMBING DETAILS MPE3

- E1.11 ROOF PLAN LAUNDRY & AUDITORIUM
- EE0.0 ELECTRICAL COVER SHEET
- EE1.0 ELECTRICAL SITE PLAN
- EE5.1 SINGLE LINE DIAGRAM
- EE5.2 SCHEDULES
- EE5.3 PANEL SCHEDULES
- EE6.1 ELECTRICAL ENLARGED SITE PLAN
- EE6.2 ELECTRICAL ENLARGED PLANS
- EE9.1 ELECTRICAL DETAILS
- EE9.2 ELECTRICAL DETAILS
- EE9.3 ELECTRICAL DETAILS
- EE9.4 GENERATOR DETAILS
- EE9.5 FUEL TANK DETAILS
- EE9.6 12KV & 5KV DISTRIBUTION SWITCHGEAR DETAILS
- EE9.7 DETAILS
- SHEETS 41

### TOTAL QUANTITY OF SHEETS = 55 FOR SFM PERMIT #22-S-4872 FOR ELECTRICAL UPGRADE OSFM #19-40-27-0001-00032

END OF DOCUMENT

### SECTION 02 41 19

### SELECTIVE DEMOLITION

### PART 1 – GENERAL

### 1.1 SCOPE OF WORK

- A. Furnish all materials, labor, equipment, and services necessary and incidental to the completion of building and site demolition work as shown on the drawings and as described within this specification manual. Work of this project shall be coordinated with the facility schedule and observe all designated No-Work periods based on occupant access requirements.
- B. Demolition requirements are shown or implied throughout the construction documents. Provide all demolition work necessary to complete the Work shown in these construction documents, whether or not specific demolition requirements are indicated. Review all documents for a full and complete understanding of demolition, salvage/reuse, relocation, and modification of systems or components.
- C. Demolition for this project shall include:
  - All mechanical and electrical work associated with the removal and replacement of the roof top Air Handler and Exhaust Fan units as well as all associated hydronic piping, electrical conduits, and controls. Demolition of associated structurally mounted support systems for mechanical and electrical.
  - 2. Tear-off of the full roofing system and flashing to the existing structure associated including demolition of all associated nailers, sealants, and anchors. See Appendix B below for reference design information.
  - 3. Removal and safing off of all mechanical and electrical equipment designated to remain as required for access to other work.
  - 4. Removal of and storage for chain link fencing, catwalks, security screen barriers, security wire, guard rails, and supports for same. Preparation of these elements for painting and reinstallation.
  - 5. Abatement work as defined in the division 00 & 01 documents. See also Appendix A below for reference design information. Contractor shall obtain all available reports from DSA prior to submitting bids.
  - 6. Drilling of concrete or concrete masonry as required for new structural anchoring, structural steel framework supports, or connections.
  - 7. Demolition of fasteners and abandoned elements to flush with existing structural surfaces.
  - 8. Preparation of existing surfaces for coating and sealing.

- 9. Modifications to site chain link fencing and gates as required for access of temporary HVAC equipment and contractor access for materials and equipment.
- 10. Earthwork for trenching and building foundations including all sawcutting of hard surfaces.
- 11. Coordinate with the utility providers for shutdown of services and the disconnect with removal of conductors, conduit, and/or piping.
- 12. Sawcutting, excavation, and removal of asphalt and concrete.
- D. Provide containment and removal of lead-containing or asbestos-containing materials necessary to execute the Work. Contractor is to contact the State's Project Director to obtain any and all information regarding hazardous materials prior to bidding and include abatement of same in the base bid.

### 1.2 REQUIREMENTS

- A. Prior to starting demolition, comply with requirements listed in related Division 01 Sections. Comply with Environmental Protection Agency (EPA) regulations and disposal regulations.
- B. Obtain and incorporate supplemental reports provided by the State as Appendices to these contract documents. These supplemental reports include, but are not limited to:
  - 1. Hazardous Materials Report prepared by Adam Laboratories, Inc. dated March 11, 2020 for Asbestos Materials.
  - 2. Hazardous Materials Report prepared by Adam Laboratories, Inc. dated March 10, 2020 for Lead Materials.
  - 3. Roof Core Sample Observation report dated 3/5/2020
  - 4. Geotechnical Report prepared by Yeh and Associates, Inc. dated February 10, 2022.

### 1.3 RELATED WORK

- A. Section 01 35 16 Alteration Project Procedures
- B. Section 01 41 00 Quality Requirements
- C. Section 01 51 00 Temporary Facilities and Controls
- D. Section 01 73 29 Cutting and Patching
- E. Section 01 74 19 Construction Waste Management

PART 2 – PRODUCTS, NOT USED

### PART 3 – EXECUTION

### 3.1 UTILITIES

- A. Locate, identify, disconnect, and cap off utility services to be demolished.
- B. Maintain and protect existing utilities to remain in service before proceeding with demolition, providing bypass connections to other parts of the building.

### 3.2 SHORING AND BRACING

A. In accordance with Section 01 41 00 Quality Requirements, provide and maintain shoring, bracing, or structural support to preserve building stability and prevent movement, settlement, or collapse.

### 3.3 DEMOLITION

- A. Conduct demolition in accordance with Section 01 35 16 Alteration Project Procedures (without disrupting occupant's use of the building).
- B. In accordance with Section 01 51 00 Temporary Facilities and Controls, conduct demolition operations and remove debris to prevent injury to people and damage to adjacent buildings and site improvements. Maintain separation of building occupants from all construction activities and provide dust and noise barriers to separate work from occupants.
- C. Perform Work in such a manner as to prevent damage to existing facilities to remain or to be salvaged. Hazardous Work shall not be left standing or hanging, but shall be knocked or pulled down or shored up to avoid damage or injury to employees or the public.

### 3.4 **PROTECTION**

- A. In accordance with Section 01 73 29 Cutting and Patching, protect building structure or interior from weather and water leakage and damage.
- B. Protect remaining walls, ceilings, floors, and exposed finishes. Erect and maintain dustproof partitions. Cover and protect remaining furniture, furnishings, and equipment.

### 3.5 CUTTING AND PATCHING

- A. In accordance with Section 01 73 29 Cutting and Patching.
- B. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.
- C. Promptly patch and repair holes and damaged surfaces of building caused by demolition. Restore ex-posed finishes of patched areas and extend finish restoration into remaining adjoining construction.

### 3.6 SALVAGE

- A. Items indicated to be removed and salvaged remain State property. Salvage items shall be removed, cleaned, and delivered to the State's designated storage area or as directed by the project manager.
- B. The Contractor shall coordinate with State's project manager to arrange for all salvage.

### 3.7 DISPOSAL

- A. In accordance with Section 01 74 19 Construction Waste Management.
- B. Unless otherwise indicated, demolished materials become Contractor's property.
- C. Promptly remove demolished materials from State's property and legally dispose of said items. Do not burn demolished materials.

### 3.8 HAZARDOUS MATERIALS

- A. Except as otherwise specified, in the event Contractor encounters on the Project site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, or other hazardous substances that have not been rendered harmless, Contractor shall immediately stop work in the area affected and report the condition to the State's project manager in writing. The work in the affected area shall not thereafter be resumed except by written agreement of State and Contractor if in fact the material is asbestos, PCB, lead, or other hazardous substances and has not been rendered harmless. The work in the affected area shall be resumed in the absence of asbestos, PCB, lead, or other hazardous substances, or when such materials have been rendered harmless.
- B. Disclose any hazardous substance or condition exposed during the work to the State's project manager for decision or remedy.

END OF SECTION

### SECTION 03 10 00

### CONCRETE FORMWORK AND ACCESSORIES

### PART 1 – GENERAL

- 1.1 GENERAL REQUIREMENTS
  - A. Requirements of Division 01 apply to all work of this section.
- 1.2 SCOPE
  - A. Design, furnish and install forms for concrete as indicated on drawings and specified here. Remove forms and shores at specified time. Clean up.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 03 21 00 Reinforcing Steel
  - B. Section 03 30 00 Cast-In-Place Concrete
  - C. Section 05 12 00 Structural Steel
  - D. Section 05 50 00 Metal Fabrications
  - E. Section 06 10 00 Rough Carpentry
  - F. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

### 1.4 QUALITY ASSURANCE

- A. General:
  - 1. Conform to all requirements of ACI 347 and ACI 318 Section 26.11.
  - 2. Concrete formwork shall be designed and constructed to safely support fluid concrete and superimposed construction loads without excessive deflection or concrete leakage. Provide bracing to maintain accurate alignment and to resist all anticipated lateral loads. Forms shall conform with drawings as to shape, line, and dimension. Design, engineering and construction of forms shall be Contractor's responsibility. Formwork for exposed concrete shall be constructed to tolerances indicated in ACI 303R.
  - 3. Cooperate and coordinate with other trades who furnish and/or install piping, conduit, reglets, anchors, inserts, sleeves, hangers, etc., as their work requires; including provisions for recesses and chases.
- B. Submittals: (Submit under provisions of Section 01 33 32)
  - 1. Product Data. Provide manufacturers data and installation instructions for the following:

- a. Tie rods and spreaders.
- b. Formwork for exposed concrete.
- c. Form coatings and release agents.
- C. Standards and References: (Latest Edition unless otherwise noted)
  - 1. 2019 California Building Code (CBC)
  - 2. American Concrete Institute (ACI)
    - a. ACI 303R "Guide to Cast-In-Place Architectural Concrete Practice"
    - b. ACI 318 "Building Code Requirements for Structural Concrete"
    - c. ACI 347R "Guide to Formwork for Concrete"
  - 3. Standard Grading and Dressing Rules #17, West Coast Lumber Inspection Bureau (For Douglas Fir Form Lumber)
  - 4. U.S. Product Standard PS 1-83 (For Plywood Form Lumber

### PART 2 - PRODUCTS

- 2.1 MATERIALS
  - A. Form Material:
    - 1. Smooth Concrete exposed to view: 5/8-inch minimum APA Plyform or steel.
    - 2. Concrete concealed from view: 5/8-inch minimum APA Plyform, steel or clean and sound 1 x 8 Standard Grade Douglas Fir.
  - B. Fiber Forms: Tubular column forms spirally constructed of laminated plies of fiber. Plies shall be laminated using a non-water sensitive adhesive and surface wax impregnated for moisture protection. Forms shall give a smooth and seamless appearance to the cast concrete. Provide reveals, as shown on the drawings, as supplied by the form manufacturer. Forms shall be as manufactured by Sonoco Products, plastic lined; Burke Smoothtube by Burke Co.; or approved equal.
  - C. Form Clamps: Assembly to have cone washers, (1 inch break back) 3/8" inch center rod.
  - D. Form Ties:
    - 1. Concrete exposed to view: Snap ties allowing full 1 inch break back.
    - 2. Concrete concealed from view: Snap ties or wire.
    - 3. Verify special spacing requirements with architectural drawings at exposed concrete.

- E. Spreaders: Metal (no wood)
- F. Form Coating: Non-grain and non-staining types of form coating that will not leave a residual matter on the face of the concrete or adversely affect proper bonding of any subsequent paint or other surface applications.
  - 1. Form coating containing mineral oils or other non-drying materials will not be permitted for any concrete work.
- G. Joint Tape: No. 471 plastic film tape 3 inches wide, as manufactured by the Industrial Tape Division of 3M Company.
- H. Expansion Joint Filler (Preformed): 1/2 inch thick; Flexcell by Celotex Corporation, Elastic Fiber Expansion Joint by Phillip Carey Mfg. Co., or Sealtight Fiber Expansion Joint by W.R. Meadows, Inc.
- I. Extruded Polystyrene Foam: ASTM C578 type IV. Dow Chemical Corp. "Styrofoam", UC Industries "Foamular", or approved equal.

### PART 3 - EXECUTION

### 3.1 FORM CONSTRUCTION

- A. Construct substantial forms to the shapes, lines, grades and elevations shown, sufficiently tight to prevent leakage of mortar, and tied, clamped and braced to prevent spreading, shifting or settling. Plywood joints shall be square and tight; plywood shall be arranged in such manner as to minimize number of joints and to provide a smooth, attractive finished concrete surface.
- B. Apply form coating to forms before reinforcing steel is in place.
- C. Sleeves, anchors and bolts, including those for angle frames, supports, ties and other materials in connection with concrete construction, shall be secured in position before the concrete is placed.
- D. Proper provisions shall be made for openings, blockouts, sleeves, offsets, sinkages, recesses and depressions required by other trades and suppliers prior to placing concrete.
  - 1. The Contractor shall also see that sleeves have been installed and other provisions have been made for the installation of mechanical, electrical and other equipment.
  - 2. Coordinate with all trades to insure proper placement of all items in forms and to provide proper blockouts wherever required.
- E. Concrete work out of alignment, level or plumb will be cause for rejection of the whole work affected and, if so rejected, such work shall be removed and replaced, as directed by Architect, with no additional cost to the Owner.
- F. Form Not Required: Concrete footings may be poured directly against cut earth where feasible and when the Architect's approval has been obtained.

- 1. See structural drawings for requirements for placing concrete footings directly against earth without forms.
- G. Use 3/4 inch minimum wood chamfer strips typical at all exposed corners unless noted otherwise on drawings.

### 3.2 CLEANING OF FORMS

- A. All dirt, chips, sawdust, rubbish, water, etc. shall be completely removed from form by water hosing and air pressure before any concrete is deposited therein. No wooden ties or blocking shall be left in concrete except where indicated for attachment of other work.
- B. Thoroughly clean and patch all holes in formwork and re-coat as required before reusing. Forms not suited to obtain concrete surfaces and tolerances in conformity with Contract requirements will be rejected by Architect.
  - 1. Reuse of forming materials shall be limited only as required to produce the finishes as specified, free from blemishes and other defects unless covered by other building materials in which case blemish free concrete is not required.

### 3.3 INSPECTION OF FORMS

A. Notify the Architect at least 48 hours in advance of the beginning of pouring operations and at the completion of formwork and location of all construction joints. An inspection of forms and joints will be made for approval of finished work and general layout only. The foregoing inspection shall in no way relieve the Contractor of responsibility of design and safety or formwork, bulkheads and shorings.

### 3.4 REMOVAL OF FORMS AND SHORING

- A. Do not remove forms until concrete has attained sufficient strength to support its weight and any construction loading. Concrete must be allowed to cure long enough to avoid damage during form removal. Contractor or his representative in charge of concrete construction shall be present during removal of forms and shores, and shall be personally responsible for safety of this operation at all times and under all conditions.
- B. As a minimum, formwork and shoring shall remain in place for the following periods:
  - 1. Concrete on grade: 24 hours
  - 2. Walls and Columns: 3 days
  - 3. Formwork may be removed and reshores installed before the times indicated above, provided the concrete has cured sufficiently to avoid damage when formwork is removed. Shores must be immediately replaced with reshores in a sequence designed to avoid inducing stress in the concrete member.

### 3.5 ADJUSTING AND CLEANING

- A. Upon completion of this Work, clean up and remove from Site all equipment and debris resulting from this work.
- B. Surfaces to be painted shall be smooth and free of substances such as dirt, wax, excessive latence, grease or materials that would prevent proper bonding of finishes.
  - 1. Removal of foregoing contaminants, and complete removal of parting and curing compounds affecting proper paint bond, shall be responsibility of this Section of Work. Sandblast cleaning shall not be employed without specific approval of Structural Engineer.

END OF SECTION

### SECTION 03 21 00

### **REINFORCING STEEL**

### PART 1 - GENERAL

### 1.1 GENERAL REQUIREMENTS

A. Requirements of Division 01 apply to all work of this Section.

### 1.2 SCOPE

- A. Unless noted otherwise, furnish and install reinforcing for all concrete, including dowels, chairs, spacers, bolsters, etc., necessary for supporting and fastening reinforcement in place as shown on the Drawings and specified herein.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 03 10 00 Concrete Formwork
  - B. Section 03 30 00 Cast-In-Place Concrete
  - C. Section 04 22 00 Concrete Unit Masonry

### 1.4 QUALITY ASSURANCE

- A. General:
  - 1. Acceptable Manufacturers: Regularly engaged in the manufacture of steel bar and welded wire fabric reinforcing.
  - 2. Installer Qualifications: Installation shall be done only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics working under an experienced supervisor.
  - 3. Welding Qualifications: Welding procedures, welding operators and welders shall be qualified in accordance with AWS D1.4 "Structural Welding Code Reinforcing Steel".
    - a. Welders whose work fails to pass inspection shall be re-qualified before performing further welding.
  - 4. Reinforcement Work shall conform to ACI 301 and ACI 318 Chapter 25, as minimum standards.
  - 5. Allowable Tolerances:
    - a. Fabrication:
      - 1) Sheared length: 1 inch
      - 2) Depth of truss bars: Plus or minus 1/2-inch
      - 3) Ties: Plus or minus 1/2-inch
      - 4) All other bends: Plus or minus 1 inch
    - b. Placement:

- 1) Concrete cover to form surfaces: Plus or minus 1/4-inch
- 2) Minimum spacing between bars: Plus or minus 1/4-inch
- 3) Crosswise of members: Spaced evenly within 2 inches of stated separation
- 4) Lengthwise of members: Plus or minus 2 inches
- c. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 2 bar diameters.
- B. Standards and References: (Latest Edition unless otherwise noted):
  - 1. 2019 California Building Code (CBC)
  - 2. American Concrete Institute (ACI)
    - a. ACI 301 "Specifications for Structural Concrete"
    - b. ACI 315R "Guide to Presenting Reinforcing Steel Design Details"
    - c. ACI 318 "Building Code Requirements for Structural Concrete"
  - 3. American Society for Testing and Materials (ASTM)
    - a. ASTM A82 "Cold Drawn Wire for Concrete Reinforcement"
    - b. ASTM A185 "Welded Steel Wire Fabric for Concrete Reinforcement"
    - c. ASTM A615 "Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
    - d. ASTM A706 "Low Alloy Steel Deformed Bars for Concrete Reinforcement"
  - 4. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice"
  - 5. American Welding Standard (AWS)
    - a. AWS D1.4 "Structural Welding Code Reinforcing Steel"
- C. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Shop Drawings: Prepare in accordance ACI 315R. Indicate bending diagrams, assembly diagrams, splicing and laps of bars and shapes, dimensions and details of bar reinforcing and assemblies. Correctness of all reinforcing requirements and work is the responsibility of Contractor. Identify such shop drawings with reference thereon to sheet and detail numbers from Contract Drawings.
    - a. Do not use scaled dimensions from Contract Drawings in determining the lengths of reinforcing bars.
    - b. No reinforcing steel shall be fabricated without approved shop drawings.
    - c. Any deviations from the contract documents must be clearly indicated as a deviation on the shop drawings.

- d. Areas of high congestion, including member joints and embed locations shall be fully detailed to verify clearances and assembly parameters and coordination with other trades.
- 2. Certified mill test reports of supplied reinforcing indicating chemical and physical analysis. Tensile and bend tests shall be performed by the mill in accordance with ASTM A615.
- 3. Product Data:
  - a. Manufacturer's specifications and installation instructions for splice devices
  - b. Bar Supports
- 4. Certificates of Compliance with specified standards:
  - a. Reinforcing bars
  - b. Welded wire fabric
  - c. Welding electrodes
- 5. Samples: Only as requested by Architect
- 6. Buy Clean California Reporting: (Submit under provisions of Section 01 33 29.08)
  - a. Provide an Environmental Product Declaration (EPD) for each mill producing eligible Structural Steel material proposed to be used on the Project. Structural Steel products to include: W-, S-, M- and HP- shapes, channels, angles, split tees, plate and round, square and rectangular ASTM A500, A847 and A1085 HSS essential to support the design loads of a structure. The following products do not require EPD's: metal buildings, steel joists, sheet and bearing piles, guard rail, light poles, cold-formed steel products, pressure vessels, crane rails, handrails, stairs and other items detailed in the AISC Code of Standard Practice (ANSI/AISC 303) Section 2.2.
  - b. Thresholds: EPD's for eligible steel products must document that GWP-100 levels do not exceed the following thresholds:

Category	Product	GWP-100 Threshold at Mill Gate as published by DGS (1)	GWP-100 Threshold if U.S. industry average fabrication is included (2)
Concrete Reinforcing Steel		0.89 tons/ton	0.98 tons/ton

- (1) Use this column to determine compliance when an EPD declares mill-only material (cradle to mill gate).
- (2) Use this column to determine compliance when an EPD declares mill material plus U.S. industry average fabrication impacts (cradle to fabricator gate).
- D. Tests and Inspections:
  - 1. A testing program is required prior to start of construction. Testing program to be

done in compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.

- 2. All reinforcing steel whose properties are not identifiable by mill test reports shall be tested in accordance with ASTM A615. One Series of tests for each missing report to be borne by the Contractor.
- 3. When inspections are indicated for reinforcement placement on the Structural drawings, a special inspector shall be employed to inspect reinforcing placement per CBC Section 1704.
- 4. When tests are indicated for reinforcing steel on the structural drawings, the reinforcing steel used shall be tested in accordance with ASTM A615. One tensile and one bend test for each 2-1/2 tons of steel or fraction thereof, shall be made.
- 5. Inspect shop and field welding in accordance with AWS D1.4, including checking materials, equipment, procedure and welder qualification as well as the welds. Inspector will use non-destructive testing or any other aid to visual inspection that he deems necessary to assure himself of the adequacy of the weld.
- 6. Tests and inspection shall be performed by Owners testing agency except when needed to justify rejected work, in which case the cost of retests and reinspection shall be borne by the Contractor.

### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement to project site in bundles marked with metal tags indicating bar size and length.
- B. Handle and store materials to prevent contamination.
  - 1. Store reinforcement in a manner that will prevent excessive rusting or coating with grease, oil, dirt, and other objectionable materials. Storage shall be in separate piles or racks so as to avoid confusion or loss of identification after bundles are broken.
- C. Deliver and store welding electrodes in accordance with AWS D1.4.

### PART 2 – PRODUCTS

### 2.01 MATERIALS

- A. Reinforcement Bars: ASTM A615, Grade 60 for all bars
  - 1. Bar reinforcement to be welded shall meet chemical requirements of ASTM A706
  - Longitudinal reinforcement in columns and beams of special moment-resisting frames and special reinforced shear walls shall meet the chemical requirements of ASTM A706
- B. Stirrups and Ties: ASTM A615, Grade 60 for all bars
- C. Steel Dowels: Same grade as bars to which dowels are connected
- D. Welded wire Fabric: ASTM A185
- E. Tie Wires: FS-QQ-W-461, annealed steel, black, 16 gauge minimum

- F. Welding Electrodes: AWS D1.4, low hydrogen, E70XX series
- G. Bar Supports:
  - 1. Typical, unless noted otherwise; CRSI Class 2 wire supports
    - a. Do not use wood, brick or other objectionable materials
    - b. Do not use galvanized supports
  - 2. Supports placed against ground: Pre-cast concrete blocks not less than 4 inches square with embedded wire.
- H. Mechanical Couplers: Comply with ACI 318 section 25.5.7.1

### PART 3 – EXECUTION

### 3.1 FABRICATION

- A. Shop fabricate reinforcement to meet requirements of Drawings.
- B. Fabricate reinforcement in accordance with the requirements of ACI 315R where specific details are not shown or where Drawings and Specifications are not more demanding.
- C. Steel reinforcement shall not be bent or straightened in a manner that will injure the material. Bars with kinks or bends not shown on the Drawings shall not be used. Heating of bars for bending will not be permitted.
- D. Reinforcing shall not be field bent or straightened without structural engineer's review.
- E. Provide offsets in rebar (1:6 maximum) where required to maintain clearances.

### 3.2 CONDITION OF SURFACES

A. Examine surfaces and conditions receiving or affecting the work. Do not proceed until unsuitable conditions have been corrected.

### 3.3 GENERAL

A. Concrete shown without reinforcing shall be reinforced as similar parts shown with reinforcing except where concrete is specifically noted to be unreinforced.

### 3.4 PLACEMENT

- A. All reinforcement shall be accurately set in place, lapped, spliced, spaced rigidly and securely held in place and tied with specified wire at all splices and crossing points. All wire tie ends shall point away from the form. Carefully locate all dowel steel to align with wall and column steel.
  - 1. Bars shall be in long lengths with laps and splices as shown. Offset laps in adjacent bars. Place steel with clearances and cover as shown. Bar laps shall be as indicated on the Drawings. Tie all laps and intersections with the specified wire.
  - 2. Maintain clear space between parallel bars not less than 1-1/2 times nominal diameter, but in no case shall clear space be less than 1-1/2 times maximum size concrete aggregate.
- 3. Reinforcing dowels for slabs shall be placed as detailed. Sleeves may be used if reviewed by the Structural Engineer before installation. Install dowel through all construction and expansion joints for all slabs on grade.
- B. Bar Supports: Support and securely fasten bars with chairs, spacers and ties to prevent displacement by construction loads or placement of concrete beyond the tolerances specified. Conform to CRSI as a minimum standard.
- C. Steel Adjustment:
  - 1. Move within allowable tolerances to avoid interference with other reinforcing steel, conduits, or embedded items.
  - 2. Do not move bars beyond allowable without concurrence of Structural Engineer.
  - 3. Do not heat, bend, or cut bars without concurrence of Structural Engineer.
  - 4. Reinforcement shall not be bent after being embedded in hardened concrete.
- D. Splices:
  - 1. Splice reinforcing as shown
  - 2. Lap Splices: Tie securely with wire to prevent displacement of splices during placement of concrete.
  - 3. Splice Devices: Install in accordance with manufacturer's written instructions. Obtain Structural Engineer's review before using.
  - 4. Do not splice bars except at locations shown without concurrence of Structural Engineer.
    - a. Where splices in addition to those indicated are required, indicate location on shop drawings clearly and highlight "for Engineer's approval".
- E. Welding:
  - 1. Welding is not permitted unless specifically detailed on Drawings or approved by Engineer.
  - 2. Employ shielding metal-arc method and meet requirements of AWS D1.4.
  - 3. Welding is not permitted on bars where the carbon equivalent is unknown or is determined to exceed 0.55.
  - 4. Welding shall not be done within two bar diameters of any bent portion of a bar which has been bent cold.
  - 5. Welding of crossing bars is not permitted.
- F. Welded Wire Fabric: Install in long lengths, lapping 24 inches at end splices and one mesh at side splices. Offset laps in adjacent widths. Place fabric in approximately the middle of the slab thickness unless shown otherwise on the Drawings by dimension. Wire tie lap joints at 12-inch centers. Use concrete blocks to support mesh in proper position.
- G. Reinforcement shall be free of mud, oil or other materials that may reduce bond at the time concrete is placed. Reinforcement with tightly adhered rust or mill scale will be accepted without cleaning provided that rusting has not reduced dimensions and weights

below applicable standards. Remove loose rust.

- H. Protection against rust:
  - 1. Where there is danger of rust staining adjacent surfaces, wrap reinforcement with impervious tape or otherwise prevent rust staining.
  - 2. Remove protective materials and clean reinforcement as required before proceeding with concrete placement.
- I. Drawing Notes: Refer to notes on Drawings for additional reinforcement requirements.
- J. Mechanical and Electrical Drawings: Refer to Mechanical and Electrical Drawings for formed concrete requiring reinforcing steel. All such steel shall be included under the work of this Section.

END OF SECTION

## SECTION 03 25 00

## CONCRETE ANCHORS

## PART 1 – GENERAL

## 1.1 GENERAL REQUIREMENTS

A. Requirements of Division 01 apply to all work of this section.

## 1.2 SCOPE

- A. Design, furnish and install concrete anchors as indicated on drawings and specified here.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 05 05 19 Post-Installed Concrete Anchors
  - B. Section 05 12 00 Structural Steel
  - C. Section 05 50 00 Metal Fabrications
  - D. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Drilled-in anchors shall be installed by an installer with at least five years of experience performing similar installations.
  - 2. Adhesive anchor installers shall be certified in accordance with the ACI- CRSI Adhesive Anchor Installer Certification Program.
- B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
  - 1. Hole drilling procedure
  - 2. Hole preparation & cleaning technique
  - 3. Adhesive injection technique & dispenser training /maintenance
  - 4. Rebar dowel preparation and installation
  - 5. Proof loading/torqueing per the contract drawings and applicable ICC ESR requirements
  - 6. Certifications: Unless otherwise authorized by the Engineer, anchors shall have the following certification: ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.
- C. Submittals: (Submit under provisions of Section 01 33 23)
  - 1. Product specifications with recommended design values and physical characteristics for epoxy dowels, expansion and undercut anchors.

- 2. Samples: Representative length and diameters of each type anchor shown on the Drawings.
- 3. Quality Assurance Submittals:
  - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
  - b. Certificates:
  - c. ICC ES Evaluation Reports
- 4. Manufacturer's installation instructions
- 5. Installer Qualifications & Procedures: Submit installer qualifications as described herein and on the drawings. Submit a letter of procedure stating method of drilling, the product proposed for use, and the complete installation procedure including the steel reinforcement detection system.
- D. Closeout Submittals: Submit the following:
  - 1. Record Documents: Project record documents for installed materials in accordance with Division 01 Closeout Submittals Section.
- 1.5 DELIVERY, STORAGE AND HANDLING:
  - A. General: Comply with Division 01 Section Product Storage and Handling Requirements
  - B. Store anchors in accordance with manufacturer's recommendations.

## PART 2 – PRODUCTS

## 2.1 MATERIALS

- A. Products and materials as indicated on the drawing general notes and details.
- B. Refer to Section 05 05 19 Post-Installed Concrete Anchors for additional information.

## PART 3 – EXECUTION

## 3.1 INSTALLATION

- A. Cast-In-Place Bolts: Use templates to locate bolts accurately and securely in formwork.
- B. Drilled-In Anchors:
  - Drill holes with rotary drills using carbide-tipped bits, and core drills using diamond core bits. Use of core drills is only acceptable where specifically allowed by the applicable ICC ESR requirements. Drill bits shall be of diameters as specified by the anchor or the adhesive manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
    - a. Cored Holes: Where anchors are to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Roughen holes to manufacturer recommended surface.

- b. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- 2. Perform anchor installation in accordance with manufacturer instructions.
- 3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
- 4. Cartridge Injection Adhesive Anchors: Follow ICC ESR requirements without exception. Unless contrary to the ICC ESR requirements, perform the following measures: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Holes may be dry, damp or wet. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected into the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
- 5. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

## 3.2 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

END OF SECTION

### SECTION 03 30 00

## CAST-IN-PLACE CONCRETE

#### PART 1 – GENERAL

- 1.1 GENERAL REQUIREMENTS
  - A. Requirements of Division 01 apply to all Work of this Section.

#### 1.2 SCOPE

- A. Furnish, place and finish cast in place concrete and related work as indicated on the Drawings and specified here.
  - 1. Install miscellaneous metal and other items furnished by other trades to be installed in concrete work.
  - 2. Provide facilities for job curing of test cylinders and transporting to Testing Laboratory.
- B. Provide grouting of steel base plates as indicated on the Drawings and specified here.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Concrete Formwork: Section 03 10 00
  - B. Reinforcing Steel: Section 03 21 00
  - C. Structural Steel: Section 05 12 00
  - E. Metal Decking: Section 05 30 00
  - F. Metal Fabrications: Section 05 50 00

### 1.4 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
  - 1. 2019 California Building Code (CBC).
  - 2. American Concrete Institute (ACI)
    - a. ACI 117 "Specification for Tolerances for Concrete Construction and Materials"
    - b. ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete"
    - c. ACI 211.2 "Standard Practice for Selecting Proportions for Structural Lightweight Concrete"
    - d. ACI 301 "Specifications for Structural Concrete"
    - e. ACI 302.1R "Guide to Concrete Floor and Slab Construction"
    - f. ACI 305R "Guide to Hot Weather Concreting"

- g. ACI 306R "Guide to Cold Weather Concreting"
- h. ACI 318 "Building Code Requirements for Structural Concrete"
- i. ACI 360R "Guide to Design of Slabs-On-Ground"
- 3. American Society for Testing and Materials (ASTM)
  - a. ASTM C31 "Making and Curing Concrete Test Specimens in the Field"
  - b. ASTM C33 "Concrete Aggregates"
  - c. ASTM C39 "Compressive Strength of Cylindrical Concrete Specimens"
  - d. ASTM C42 "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"
  - e. ASTM C94 "Ready-Mixed Concrete"
  - f. ASTM C109 "Test of Hydraulic Cement Concrete"
  - g. ASTM C143 "Slump of Hydraulic Cement Concrete"
  - h. ASTM C150 "Portland Cement"
  - i. ASTM C172 "Sampling Freshly Mixed Concrete by the Volumetric Method"
  - j. ASTM C192 "Making and Curing Concrete Test Specimens in the Laboratory"
  - k. ASTM C260 "Air-Entraining Admixtures for Concrete"
  - I. ASTM C330 "Lightweight Aggregates for Structural Concrete"
  - m. ASTM C494 "Chemical Admixtures for Concrete"
  - n. ASTM C567 "Standard Test Method for Determining Density of Structural Lightweight Concrete"
  - o. ASTM C618 "Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete"
  - p. ASTM C685 "Volumetric Batching and Continuous Mixing"
  - q. ASTM C1157 "Hydraulic-Cement"
- B. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Concrete mix designs. See "Mix Design" below. Include results of test data used to establish proportions.
  - 2. Certificates of Compliance from Manufacturer
    - a. Cement certificates
    - b. Aggregates
    - c. Admixtures

- 3. Data regarding hardeners and sealers.
- 4. Grout samples for sacked surface textures and colors upon Architects request only.
- 5. Layout drawings for construction, control and expansion joints.
- 6. Transit-mix delivery slips:
  - a. Keep record at the job site showing time and place of each pour of concrete, together with transit-mix delivery slips certifying contents of the pour.
  - b. Make the record available to the Architect for his inspection upon request.
  - c. Upon completion of this portion of the work, deliver the record and the delivery slips to the Architect.
- 7. See Section 03 21 00 for reinforcing steel submittals.
- C. Tests and Inspections:
  - 1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
  - A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - The following tests shall be made by a recognized testing laboratory selected by the Owner and approved by the governing agency. All tests shall be in accordance with the previously mentioned standards and ACI 318 Section 26.12. A complete record of all tests and inspections shall be kept per CBC Section 1903.2.
    - a. Compressive Strength: Make and cure in accordance with ASTM C-31. Test in accordance with ASTM C-39 and ACI 318 Section 26.12.
      - 1) A record shall be made of time and of locations of concrete from which samples were taken.
      - 2) Four identical cylinders shall be taken from each pour of 150 cubic yards or 5000 square feet or part thereof, being placed each day per ACI 318 Section 26.12.2. One cylinder shall be tested at age 7 days, and two at age 28 days unless otherwise specified. Preserve remaining cylinder for future use.
    - b. Drying Shrinkage: (applies to lightweight concrete only unless noted otherwise)
      - 1) A record shall be made of time cylinders and of locations of concrete from which samples were taken.
      - 2) Three identical 4" x 4" x 11" specimens shall be made from same concrete as used in structure. Percent of shrinkage shall be reported at 21 days after 7-day moist curing period. Average results of 3 specimens shall be used as the accepted value. The value for laboratory cast specimens shall not exceed .075%.

If field test specimens are used in lieu of laboratory specimens, a tolerance of +33% may be used.

- 3) Test specimens in accordance with ASTM C157.
- c. Concrete consistency (slump) shall be tested in accordance with ASTM C143.
- 4. Provide full time inspection per CBC Section 1704.3 during the taking of test specimens and during the placing of all concrete and embedded steel.
- 5. See Section 03 21 00 for reinforcing steel tests and inspections.
- 6. Provide concrete batch plant inspections per ASTM C685.

## PART 2 - PRODUCTS

#### 2.1 MATERIAL

- A. Portland Cement: ASTM C 150, Type II or Type V. One brand of cement shall be used throughout to maintain uniform color for all exposed concrete.
- B. Concrete Aggregate: Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to grading requirements of appropriate ASTM Standards and ACI 318.
  - 1. Concrete Aggregates for Standard Weight Concrete: ASTM C 33. Aggregate shall be crushed granite or Perkins type.
  - 2. Concrete Aggregates for Lightweight Concrete: ASTM C330 to produce concrete weighing no more than 116 pcf at 28 days. Aggregate shall be vacuum saturated expanded shale as produced through the rotary kiln method.
- C. Water: Clean and free from injurious amounts of oil, acids, alkali, organic matter and other deleterious substances; suitable for domestic consumption.
- D. Admixtures shall be subject to prior approval by the Architect, in accordance with ACI 318 Section 26.4.1.4. Calcium Chloride is not permitted.
  - 1. Water Reducing
    - a. ASTM C494 Type A for use in cool weather.
    - b. ASTM C494 Type D for use in hot weather.
  - 2. Air Entraining
    - a. Conform to ASTM C 260
  - 3. Fly Ash
    - a. Conform to ASTM C 618
  - 4. Mid-Range Water-Reducers
    - a. Master Builders "Polyheed" or approved equal.

- 5. Fly Ash Pozzolan
  - a. Conforming to ASTM A-618 Class F
- E. Slab on Grade Vapor Retarder
  - 1. Vapor Retarder must have the following qualities:
    - a. 15 mil thickness minimum
    - b. WVTR less than 0.008 as tested by ASTM E 96
    - c. ASTM E 1745 Class A (Plastics)
  - 2. Vapor Retarder Products
    - a. Stego Wrap Vapor Retarder by STEGO Industries LLC.
    - b. Perminator by W.R. Meadows.
  - 3. Vapor Retarder Tape
    - a. Water Vapor Transmission Rate: ASTM E 96, 0.3 perms or lower
    - b. Minimum 6-mils thick
    - c. Minimum 3 3/4 inches wide
    - d. Manufactured from High Density Polyethylene
    - e. Pressure Sensitive Adhesive
- F. Sand: Clean, dry, well graded.
- G. Abrasive aggregate for non-slip finish: Fused aluminum oxide grits, graded 12/30. Use factory-graded rustproof and non-glazing material that is unaffected by freezing, moisture and cleaning materials.
  - 1. Products offered by manufacturers to comply with the above requirements include: A-H Alox; Anti-Hydro Waterproofing Co., Toxgrip; Toch Div. Carboline, or approved equal.
- H. Expansion Joint Filler:
  - 1. Joint fill shall be a preformed non-extruded resilient filler, saturated with bituminous materials and conforming to ASTM D 1751. Products shall be equivalent to Burke "Fiber Expansion Joint", W.R. Meadows "Fibrated Expansion Joint Filler", or approved equal.
- I. Bonding Agent: Sonneborn "Sonobond"; the Euclid Chemical Company "Euco-Weld"; Larsen Products Corp., "Weld-Crete" or approved equivalent.
- J. Concrete Sealer: Cure and Seal, as manufactured by the Euclid Chemical Company "Aqua-Cure VOX", Sonneborn "Kure-N-Seal WB", Burke "Spartan-Cote",W.R. Meadows "Intex" or approved equal conforming to ASTM C-309, Type I, Class B requirements, and conforming to State of California Air Resources Board VOC Regulations.

- K. Concrete Hardener/Sealer: Clear, water soluble, sprayable in-organic silicate based hardener/sealer or acrylic co-polymer resin. Products shall be equal to Euclid Chemical Company "Eucosil", Burke "Spartan-Cote", Sonneborn "Sonosil", W.R. Meadows "Pena-Lith", or approved equal and must conform to State of California Air Resources Board VOC Regulations.
- L. Concrete Cure: Water based curing compound conforming to ASTM C-309, Type 1, Class A and B, and AASHTO Specification M-148; Type 1, Class A and B requirements, and State of California Air Resources Board VOC Regulations. Product shall be equivalent to Euclid Chemical Company "Kurez VOX", Burke "No. 1127" or "Aqua-Resin Cure", W.R. Meadows "1100 Clear", or approved equal.
- M. Non-Shrink Grout: See Section 2.02.A.6.

## 2.2 CONCRETE

- A. Concrete Mixes:
  - 1. Type A Concrete: Foundations, etc.

Strength: 3000 lbs. per square inch at 28 days.

Maximum Aggregate Size: 1-1/2 inch.

Cement Content: As required by mix design (ACI 318 Section 26.4.3)

5.0 sacks per yard minimum

Maximum Water to Cement Ratio: 0.58

Admixture: Water Reducing

Weight: 145 lbs. per cubic foot

Use for unexposed foundation concrete except as otherwise specified. At Contractor's option, Type C concrete may be substituted for this.

2. Type B Concrete: Lightweight – Fill @ metal deck

Strength: 3,000 lbs. per square inch at 28 days

Maximum Aggregate Size: 3/4 inch

Minimum Cement Content: As required by mix design (ACI 318 Section 26.4.3)

5.0 sacks per yard minimum

Maximum Water to Cement Ratio: 0.52

Admixture: Water reducing

Air Entrainment: As required for UL rating (4%-7%)

Weight: 113 ± 3 lbs. per cubic foot. (Equilibrium Density per ASTM C567)

3. Type C Concrete: Slabs, paving, etc.

Strength: 3500 lbs. per square inch at 28 days.

Maximum Aggregate Size: 1 inch

Minimum Cement Content: As required by mix design. (ACI 318 Section 26.4.3)

6.0 sacks per yard minimum

Maximum Water to Cement Ratio: 0.45

Admixture: Water reducing

Weight: 145 lbs. per cubic foot

Use for building slab on grade

- 4. Grout shall be non-shrink, non-metallic, flowable Type "713" or "928" by BASF.
  - a. Metallic grout equivalent to Master Builders "Embeco" may be used only where covered by earth, concrete, or masonry.
  - b. Acceptance by Architect required before using.
- B. Consistency of Concrete: Concrete slump, measured in accordance with ASTM C 143, shall fall within following limits.
  - 1. For General concrete placement (with no admixtures): 4 inch ± 1 inch.
  - 2. Mixes employing the specified mid-range water reducer shall provide a measured slump not to exceed 7 inch <u>+</u>1 inch after dosing, 2 inch <u>+</u>1 inch before dosing.
  - 3. Concrete slump shall be taken at point of placement. Use water reducing admixtures as required to provide a workable consistency for pump mixers. Water shall not be added at the jobsite without written review by the structural engineer.
- C. Mix Design:
  - Initial mix design shall be prepared for all concrete in accordance with ACI 318 Section 26.4.3. Mix proportions shall be determined in accordance with ACI 318 Section 26.4.3 or 26.4.4. In the event that additional mix designs are required due to depletion of aggregate sources, aggregate not conforming to Specifications or at request of Contractor, these mixes shall be prepared as above.
  - 2. Contractor shall notify the Testing Laboratory and Architect of intent to use concrete pumps to place concrete so that mix designs can be modified accordingly.
  - 3. Fly ash shall not exceed 25% of the total cementitious material.
  - 4. Provide 6% air entrainment typical for exterior concrete exposed to freeze-thaw cycles.5. Owner's testing laboratory shall review all mix designs before submittal. A registered civil engineer with experience in concrete mix design shall review the concrete mixes.
- D. Mixing:

- 1. Equipment: All concrete shall be machine mixed. Provide adequate equipment and facilities for accurate measurement and control of materials.
- 2. Method of Mixing:
  - a. Transit Mixing: Comply with ASTM C 94. Ready mixed concrete shall be used throughout, except as specified below.
  - b. On-Site Mixing: Use only if method of storing material, mixing of material and type of mixing equipment is approved by Architect. Approval of site mixing does not relieve Contractor of any other requirements of Specifications.
  - c. Mixing shall be in accordance with ASTM C94 or ASTM C685.
- 3. Mixing Time: After mix water has been added, concrete shall be mixed not less than 1-1/2 minutes nor more than 1-1/2 hours. Concrete shall be rejected if not deposited within the time specified.
- 4. Admixtures:
  - a. Air entraining and chemical admixtures shall be charged into mixer as a solution and shall be dispensed by an automatic dispenser or similar metering device. Powdered admixtures shall be weighed or measured by volume as recommended by manufacturer. Accuracy of measurement of any admixture shall be within plus or minus 3%.
  - b. Two or more admixtures may be used in same concrete, provided such admixtures are added separately during batching sequence, and provided further that admixtures used in that combination retain full efficiency and have no deleterious effect on concrete or on properties of each other.
  - c. All admixtures are to be approved by Structural Engineer prior to commencing this work.
- 5. Retempering:
  - a. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall be discarded, not retempered.
  - b. Indiscriminate addition of water to increase slump is prohibited.
  - c. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded. Water shall be incorporated by additional mixing equal to at least half of total mixing time required. Any addition of water above that permitted by limitation of water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain proper water-cement ratio. Such additions shall only be used if approved by Architect. In any event, with or without addition of cement, not more than 2 gallons of water per cubic yard of concrete, over that specified in design mix, shall be added.
- 6. Cold Weather Batching: When average of the highest and lowest air temperature falls below 40 degrees F for more than three consecutive days, provide adequate equipment for heating concrete materials. No frozen materials or materials containing ice shall be used. When placed in forms, concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed per ACI 301.

 Hot Weather Batching: Concrete deposited in hot weather shall have a placing temperature below 90 degrees F per ACI 301. If necessary, ingredients shall be cooled to accomplish this.

## 2.3 FLOOR LEVELING AND FILL MATERIALS

- A. Epoxy Concrete Mortar: Floor leveling, non-shrink trowel applied epoxy concrete mortar; TPM 115 General Polymers Corp., A-H Emery Epoxy Topping #170 Anti-Hydro Corp., or approved equal, where areas to fill are less than 1/4 inch thick.
- B. Concrete Mortar: Floor leveling, patching and repair, non-shrink trowel applied concrete mortar; Master Builders EMBECO 885, Euclid EUCO, or approved equal, where areas of fill are greater than 1/4 inch thick.
- C. Cementitious Floor Leveling Material: Shall be self-leveling or trowelable with a minimum 28day compressive strength of 3000 psi in accordance with ASTM C-109. Material shall be equal to Quickrete No. 1249, Ardex V-800/K-55, Mapei "Ultra/Flex" or approved equal.

## PART 3 – EXECUTION

## 3.1 PLACEMENT

- A. Before any concrete is placed, the following items of work shall have been completed in the area of placing.
  - 1. Forms shall have been erected, adequately braced, cleaned, sealed, lubricated if required, and bulkheaded where placing is to stop.
  - 2. Any wood forms other than plywood shall be thoroughly water soaked before placing any concrete. The wetting of forms shall be started at least 12 hours before concreting.
  - 3. Reinforcing steel shall have been placed, tied and supported.
  - 4. Embedded work of all trades shall be in place in the forms and adequately tied and braced.
  - 5. The entire place of deposit shall have been cleaned of wood chips, sawdust, dirt, debris, hardened concrete and other foreign matter. No wooden ties or blocking shall be left in the concrete except where indicated for attachment of other work.
  - 6. Reinforcing steel, at the time the concrete is placed around it, shall be cleaned of scale, mill scale or other contaminants that will destroy or reduce bond.
  - 7. Concrete surfaces to which fresh concrete is to be bonded shall be brush cleaned to remove all dust and foreign matter and to expose the aggregate, and then coated with the bonding adhesive herein specified.
  - 8. Prior to placing concrete for any slabs on grade, the moisture content of the subgrade below the slabs shall be adjusted to at least optimum moisture.
  - 9. No concrete shall be placed until formwork and reinforcement has been approved by Architect. Clean forms of all debris and remove standing water. Thoroughly clean reinforcement and all handling equipment for mixing and transporting concrete. Concrete shall not be placed against reinforcing steel that is hot to the touch. Notify Structural Engineer 48 hours in advance of concrete pour.

- B. Conveying: Handle concrete from mixer to place of final deposit by methods which will prevent separation or loss of ingredients. Deposit concrete in forms as nearly as practicable at its final position in a manner which will insure that required quality is obtained. Chutes shall slope not less than 4 inches and not more than 6 inches per foot of horizontal run.
- C. Depositing: Deposit concrete into forms in horizontal layers not exceeding 24 inches in thickness around building, proceeding along forms at a uniform rate and consolidating into previous pour. In no case shall concrete be poured into an accumulation of water ahead of pour, nor shall concrete be flowed along forms to its final place of deposit. Fresh concrete shall not be permitted to fall from a height greater than 6 feet without use of adjustable length pipes or, in narrow walls, of adjustable flexible hose sleeves. Concrete shall be scheduled so that placing is a continuous operation for the completion of each section between predetermined construction joints. If any concreting operation, once planned, cannot be carried on in a continuous operation, concreting shall stop at temporary bulkheads, located where resulting construction joints will least impair the strength of the structure. Location of construction joints shall be as shown on the drawings or as approved by Structural Engineer. The rate of rise in walls shall not be less than 2 feet per hour.
  - Consolidation: Concrete shall be thoroughly compacted and worked to all points with solid continuous contact to forms and reinforcement to eliminate air pockets and honeycombing. Power vibrators of approved type shall be used immediately following pour. Spading by hand, hammering of forms or other combination of methods will be allowed only where permitted by Structural Engineer. In no case shall vibrators be placed against reinforcing steel or used for extensive shifting of deposited fresh concrete. Provide and maintain standby vibrators, ready for immediate use.
  - Hot Weather Concreting: Unless otherwise directed by the Architect, perform all work in accordance with ACI 305 when air temperature rises above 75 degrees F and the following:
    - a. Mixing Water: Keep water temperature as low as necessary to provide for the required concrete temperature at time of placing. Ice may be required to provide for the design temperature.

Aggregate: Keep aggregate piles continuously moist by sprinkling with water.

Temperature of Concrete: The temperature of the concrete mix at the time it is being placed in the forms shall not exceed 90 degrees F per ACI 301. The method employed to provide this temperature shall in no way alter or endanger the design mix or the design strength required.

Dampen subgrade and formwork before placing concrete. Remove all excess water before placing concrete. Keep concrete continuously wet when air temperature exceeds 85 degrees F for a minimum of 48 hours after placing concrete. For slab on grade construction, see Section 3.1.E.

Protection: Minimize evaporation from concrete in place by providing shade and windbreaks. Maintain such protection in place for 14 days minimum.

3. Cold Weather Concreting: Follow recommended ACI 306 procedures when average of the highest and lowest air temperature falls below 40 degrees F for more than three consecutive days, as approved by Architect. Concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed as shown in ACI 301. No chemicals or salts shall be used to prevent freezing and no accelerating agents shall be used without prior approval from Architect.

- D. Construction Joints: Install only as indicated and noted on Drawings. Joints not indicated on Drawings shall be so located, when approved, as to least impair strength of structure, and shall conform to typical details. Construction joints shall have level tops, vertical sides. Horizontal construction joints shall be thoroughly cleaned and roughened by removing entire surface film and exposing clean aggregate solidly embedded in mortar matrix. Joints between concrete and masonry shall be considered construction joints. Vertical construction joints need not be roughened. See Drawings for doweling and required keys.
  - 1. Roughen construction joints by any of following methods:
    - a. By sandblasting joint.
    - b. By thoroughly washing joint, using a high pressure hose, after concrete has taken initial set. Washing shall be done not less than 2 hours nor more than 4 hours after concrete has been poured, depending upon setting time.
    - c. By chipping and wire brushing.
  - All decisions pertaining to adequacy of construction joint surfaces and to compliance with requirements pertaining to construction joints shall be reviewed with the Structural Engineer.
  - 3. Just before starting new pour, horizontal and vertical joint surfaces shall be dampened (but not saturated).
  - 4. Before placing regular concrete mix, horizontal construction joint surfaces shall be covered with a layer of mortar composed of cement and fine aggregate of same proportions as that used in prescribed mix, but omitting coarse aggregate.
  - 5. For slabs, construction joints shall be in locations shown on plan. If not shown, locate at intervals not exceeding 150 feet in each direction. Refer to drawings for proper details for reinforcing at construction joints.
- E. Concrete Slabs on Grade:
  - 1. Exterior and interior concrete slabs on grade shall be poured as required under this Section. Base shall be accurately leveled and compacted prior to placing of concrete.
  - 2. Typically, interior slabs on grade shall be poured over a minimum of four (4 inch) inches of compacted crushed rock, unless otherwise indicated, over a vapor retarder.
  - Protect slab on grade subbase from moisture prior to placing concrete. Avoid wetting rock layer to allow adequate concrete curing and avoid future vapor transmission. If the subbase has been wet excessively, verify that water has been eliminated prior to placement of concrete.
  - 4. Vapor Retarder installation shall be in accordance with manufacturer's instructions and ASTM E 1643.

a. Unroll Vapor Retarder with the longest dimension parallel with the direction of the pour.

- b. Lap Vapor Retarder over footings and seal to foundation walls.
- c. Overlap joints 6 inches and seal with specified tape.

CAST-IN-PLACE CONCRETE 03 30 00 - 11 d. Seal all penetrations (including pipes) per manufacturer's instructions.

e. No penetration of the Vapor Retarder is allowed except for reinforcing steel and permanent utilities.

f. Repair damaged areas by cutting patches of Vapor Retarder, overlapping damaged area 6 inches and taping all four sides with tape.

- F. Control Jointing Slabs on Grade:
  - 1. Joints shall be in locations indicated on Drawings, or as directed by Architect.
  - 2. Joints in interior slabs shall be made by one of following methods:
    - a. By use of construction joints laid out in checkerboard pattern; pour and allow alternate slabs to set; fill out balance of checkerboard pattern with second pour.
    - b. By use of dummy groove joints at least 1/4 depth of slab, and at least 1/8 inch wide. These joints may be sawcut as soon as wet concrete can support the weight of the equipment and operator. Delaying sawcutting past this point will make jointing ineffective.
  - 3. Control jointing in exterior paving slabs shall be laid out in a checkerboard pattern; pour as described above, but with joint edges tooled to provide a uniform joint at least 3/8 inch in depth.
  - 4. Slab reinforcing need not be terminated at control joints.
  - 5. Construction and expansion joints shall be counted as control joints.
- G. Expansion Joints:
  - 1. Unless otherwise indicated, use 3/8 inch thick expansion joint filler. See Section 2.1.H
  - 2. Joints in interior slabs on grade shall be only in locations indicated.
  - 3. Joints in exterior slabs on grade shall be installed at each side of structures, at curb transitions opposite apron joints, at ends of curb returns, at back of curb when adjacent to sidewalk, and at uniformly spaced intervals not exceeding 20 feet.
  - 4. Edges of concrete at joints shall be edger finished to approximately 3/8 inch radius.
  - 5. Interrupt reinforcing at all expansion joints.
- H. Score markings on exterior slabs on grade shall be located as indicated. Where not indicated, mark slabs into rectangles of not less than 12 square feet nor more than 20 square feet using a scoring tool which will leave edges of score markings rounded.

#### 3.02 CURING AND PROTECTION

A. Curing: Exposed surfaces of all concrete used in structure shall be maintained in a moist condition for at least 7 days after placing. The following final curing processes shall normally be considered to accomplish this. Concrete shall be maintained at not less than 50 degrees F nor more than 100 degrees F for a period of 72 hours after being deposited.

- 1. Flatwork to be exposed, stained, or painted shall have curing process submitted and approved by the architect prior to construction.
- 2. Initial Curing Process Flat Work:
  - a. Mist Spraying: As soon as troweling of concrete surfaces is completed, exposed concrete shall be sprayed continuously with a special atomizer spray nozzle, capable of producing a fine mist. Spraying shall be done without any dripping of water from nozzle. Amount of spraying shall be such as to maintain surface of concrete moist without any water accumulating on surface. Maintain spraying for a minimum of 12 hours, or until such time as hereinafter described curing process is applied. Mist spraying will not normally be required when the ambient air temperature is below 90 degrees F.
- 3. Final Curing Process Flatwork: Except as noted, use any of following:
  - a. Water Curing: Concrete shall be kept wet by mechanical sprinklers or by any other approved method which will keep surfaces continuously wet.
  - b. Saturated Burlap Curing: Finished surfaces shall be covered with a minimum of two layers of heavy burlap which shall be kept saturated during the curing period.
  - c. Curing Compounds: Membrane curing compounds of chlorinated rubber or resin type conforming to ASTM C309 may be used only if specifically approved by Architect. Use of membrane curing compound will not be permitted on surfaces to be painted, or to receive ceramic tile, membrane water-proofing or hardeners and sealers. Membrane curing compound may be used in areas to receive resilient floor tile, provided it is wax-free, compatible with adhesive used and approved by adhesive manufacturer. Agitate curing compounds thoroughly by mechanical means continuously during use and spray or brush uniformly in accordance with manufacturer's recommendations. Apply immediately following final finishing operation. All curing compounds shall conform to State of California Air Resources Board VOC Regulations.
  - d. Waterproof paper conforming to ASTM C 171, or opaque polyethylene film, may be used. Concrete shall be covered immediately following final finishing operation. Anchor paper or film securely and seal all edges in such a manner as to prevent moisture escaping from concrete.
- 4. Curing Process Formed Surfaces: Forms heated by sun shall be kept moist during curing period. If forms are to be removed during curing period, curing as described for flatwork shall be commenced immediately.
- B. Refer to Drawings for areas of concrete slab not to receive curing compounds or hardening compounds. Where concrete floors are to receive heavy duty coatings, waterproof coatings and the like, verify with coating installer the type of finish required for specified coating.
- C. Protection: Contractor shall be responsible for protection of finished concrete against injury by rain, cold, vibration, animal tracks, marking by visitors, vandalism, etc.
- D. Provide additional curing agents or compounds, not necessarily listed herein, but as recommended and or required for use with shake type hardeners or other special coatings and coverings by their manufacturers for a complete and proper installation.
- 3.3 FINISHES

- A. Formed Surfaces:
  - Rough Form Finish: Surfaces shall be reasonably true to line and plane with no specified requirements for selected facing materials. Tie holes and defects shall be patched and fins exceeding 1/4 inch in height shall be rubbed down with wooden blocks. Fins and other rough spots at surfaces to receive membrane waterproofing shall be completely removed and the surfaces rubbed smooth. Otherwise, surfaces shall be left with the texture imparted by forms.
    - a. Rough finish shall be used for the following areas:
      - 1) Below grade and unexposed surfaces.
  - 2. Smooth Plywood Form Finish: Finish shall be true to line and plane. Tie holes and defects shall have been patched and ground with surface fins removed. Arrangement of plywood sheets shall be orderly, symmetrical, as large as practical and free of torn grain or worn edges. Surface concrete shall be treated with 1 part muriatic acid, in three parts water solution, followed immediately by a thorough rinsing with clear water. Surfaces which are glazed, have efflorescence, or traces of form oil, curing compounds or parting compounds shall be cleaned or treated to match other formed surfaces, except as otherwise indicated or specified.
    - a. Smooth Plywood Form Finish shall be used for the following areas:
      - 1) All surfaces above grade unless otherwise specified.
      - 2) At Contractor's option, may also be used in lieu of rough form finish.
  - 3. Smooth Plastic Liner Finish: Surface shall be smooth, concrete free of honeycombing, air pockets larger than 1/8 inch in diameter, and fins.
    - a. This finish shall be used only where indicated on the Drawings.
- B. Flatwork:
  - 1. Unless otherwise indicated or specified, flatwork shall have an integral monolithic finish.
  - 2. Integral Monolithic Finish: Apply as soon as freshly poured concrete slabs will bear weight of workers. Pour slabs full thickness to finish floor elevations indicated. At proper time, tamp surface repeatedly with a wire mesh or grid tamper in a manner to force aggregate down below surface and to bring sufficient mortar to surface to provide for a smooth coating of cement mortar over entire surface. Allow surface mortar to partially set, then float with wooden floats and finish with one of following, as required.
    - Broom Finish: Steel trowel surface to a smooth dense surface free of lines, tool marks, cat faces and other imperfections. After troweling, and before final set, give surface a broom finish, brushing in direction noted on Drawings, or as directed.
      Broom finish shall be used typically on exterior flatwork except as otherwise indicated or specified and shall be "medium" texture as approved by Architect.
    - b. Smooth Steel Trowel Finish: Apply 2 steel trowelings to obtain hard, smooth surface. All lips, irregularities, uneven levels, etc. shall be worked out before last troweling. All interior flatwork shall have a smooth steel trowel finish unless specified otherwise.
  - 3. Tolerances:

- a. For tolerances not indicated, refer to ACI 117.
- b. Slabs on grade Comply with F<sub>F</sub> & F<sub>L</sub> as specified by Architect, or at a minimum shall be sufficiently even to contact a 10' long straightedge with a tolerance of 1/8 inch.
- c. Concrete over metal deck Refer to Section 05 30 00 for minimum requirements.
- d. Elevated slabs Comply with Architectural requirements.
- e. Finished surfaces of exterior integral finished flatwork shall not vary more than 1/4 inch from a 10' long straightedge, except at grade changes.
- C. Sacked Surfaces: Exposed surfaces that are unacceptable in appearance to the Architect shall be sacked.
  - 1. Prepare concrete surfaces in accordance with the referenced standards. Remove any form release materials by stoning by hand, power grinding or other method approved by the Architect.
  - 2. Prepare concrete surfaces to receive sack finishing with a light sand blasting.
  - 3. For best results, grout application and rubbing should be performed when areas to be treated are shaded and during cool, damp weather. When work is to be performed in hot and dry weather, a fog spray should be available for continuous use.
  - 4. Prepare grout samples for matching of concrete surfaces for approval by the Architect. These shall be made in the following proportions of gray cement to white cement to sand: 1:1:2, 1:2:3, and 2:1:3, etc. until the correct matching color is obtained on the test areas. Sand should be fine enough to pass the Number 30 sieve. Mixes should be made to a good workable consistency in a clean container and the mix with the best color chosen, or modified if needed.
  - 5. Provide sufficient qualities of sand and cement from the same source for the complete work at the job site.
  - 6. Mixing and Application:
    - a. Mixing of grout on the job should be timed for it to be used up within 1 to 1-1/2 hours.
    - b. Let the grout stand 20 to 30 minutes after mixing, and then remixed before applying.
    - c. Soak the concrete surface thoroughly with water at least 15 minutes before applying grout and again just before application so that the surface is adequately wet during the operation.
    - d. Apply grout with plasterer's trowel or sponge rubber float in sweeping strokes from the bottom up. Brush or spray gun applications may be used when approved by the Architect.
    - e. Work in freshly applied grout vigorously with a sponge rubber float, then let sit until some of its plasticity is gone but not until it loses its damp appearance. At this point it shall be rubbed with clean, dry burlap to remove the excess grout, leaving no visible film on the surface but filling all air holes.
    - f. Keep the surface wet for a day after grouting and sack rubbing are completed.

7. Alternate methods of application and materials shall be subject to the approval of the Architect.

## 3.4 PATCHING

- A. Formed Surfaces:
  - 1. Promptly upon removal of contact forms and after concrete surfaces have been inspected, form ties shall be removed and all necessary patching and pointing shall be expertly done.
  - 2. Honeycombed areas shall be removed down to sound concrete, coated with a bonding grout or approved compound and patched using a low shrinkage high bond mortar. Patched areas shall be cured by being kept damp for at least 5 days.
  - 3. Tie holes shall be cleaned, dampened and filled solid with patching mortar or cement plugs of an approved variety.
- B. Slabs on Grade: After entire slab is finished, shrinkage cracks that may appear shall be patched as follows:
  - 1. Where slab is not exposed or where appearance is not important, cracks larger than 1/32 inch wide shall be filled with cement grout and struck off level with surface.
  - 2. Where slab is exposed and appearance is important, unsightly cracks shall be repaired in a manner satisfactory in appearance to Architect. If this cannot be accomplished, concrete shall be considered defective.

## 3.5 DEFECTIVE CONCRETE

- A. Defective concrete shall mean any of the following:
  - 1. Concrete not meeting 100 percent of the specified 28 day compressive strength.
  - 2. Concrete exhibiting rock pockets, voids, spalls, streaks, cracks, exposed reinforcing to extent that strength, durability, or appearance is adversely affected.
  - 3. Concrete significantly out of place, line, or level.
  - 4. Concrete not containing the required embedded items.
- B. Upon determination that concrete strength is defective:
  - 1. Should cylinder tests fall below minimum strength specified, concrete mix for remainder of work shall be adjusted to produce required strength. Core samples shall be taken and tested from cast-in-place concrete where cylinders and samples indicate inferior concrete with less than minimum specified strength.
    - Cores of hardened concrete shall be taken and tested in accordance with ASTM C 42 and C 39. Number and location of such cores shall be subject to the approval of Architect.
    - b. Cost of core sampling and testing will be paid for by the Contractor.
    - c. "85 percent" reduction in ACI 318 Section 26.12.4 will not justify low cylinder tests.

- C. Upon determining that concrete surface is defective, Contractor may restore concrete to acceptable condition by cutting, chipping, pointing, patching, grinding, if this can be done without significantly altering strength of structure. Permission to patch defective areas will not be considered a waiver of the right to require removal if patching does not, in the opinion of the Architect, satisfactorily restore quality and appearance.
- D. If core tests indicate that concrete is below the strength specified, or if patching does not restore concrete to specified quality and appearance, the concrete shall be deemed defective, and shall be removed and replaced without additional cost to the Owner.
- E. No repair work shall begin until procedure has been reviewed by the Architect and Structural Engineer.

## 3.6 SURFACE HARDENER AND SEALER

- A. Seal all interior exposed flatwork with clear sealer, except surfaces receiving ceramic tile, quarry tile, poured flooring or other special finishes specified, or as scheduled on the Drawings.
  - 1. Apply sealer in 2 or 3 coats, in accordance with manufacturer's directions, using the maximum quantity recommended.
    - a. Concrete floors must be thoroughly cured for a minimum of 30 days and completely dry before treatment.
    - b. Surfaces to be treated must be clean, free of membrane curing compounds, dust, oil, grease and other foreign matter.
    - c. Upon completion, concrete surfaces shall be clean and without discoloration or traces of excess hardener left on the surface.
- B. Apply sprayable hardener/sealer at locations as scheduled or as indicated on the Drawings. Apply in accordance with the manufacturer's favorably reviewed application instructions and recommendations.

## 3.7 GROUTING

- A. Prepare and place grout materials at locations as indicated on the Drawings in accordance with the manufacturer's recommendations and installation instructions.
- B. Pack grout materials solidly between bearing surfaces and bases or plates as indicated and to ensure no voids.

## 3.8 ADJUSTING AND CLEANING

A. Remove all debris, excess materials, tools and equipment resulting from or used in this operation at completion of this work.

## END OF SECTION

## SECTION 04 05 00

## MORTAR AND GROUT

## PART 1 – GENERAL

- 1.1 GENERAL REQUIREMENTS
  - A. The requirements of Division 01 apply to all Work of this Section.

## 1.2 SCOPE

- A. Provide all materials, labor and accessories as required and specified for complete mortar and grout installation in masonry walls.
- 1.3 RELATED WORK (See also Table of Contents):
  - A. Reinforcing Steel: Section 03 21 00
  - B. Cast-In-Place Concrete: Section 03 30 00
  - C. Concrete Unit Masonry: Section 04 22 00

## 1.4 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
  - 1. 2019 California Building Code (CBC)
  - 2. TMS 402-16 Building Code Requirements for Masonry Construction
  - 3. TMS 602-16 Specification for Masonry Structures
  - 4. ASTM C144 Aggregate for Masonry Mortar
  - 5. ASTM C150 Portland Cement
  - 6. ASTM C207 Hydrated Lime for Masonry Purposes
  - 7. ASTM C270 Standard Specification for Mortar for Unit Masonry
  - 8. ASTM C404 Aggregates for Grout
  - 9. ASTM C476 Standard Specification for Grout for Masonry
  - 10. ASTM C1019 Method of Sampling and Testing Grout
- B. Tests and Inspections:
  - 1. A testing program is required prior to start of construction. Testing program to be done in Compliance with CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 2. All tests and inspections herein are to be performed by an independent testing laboratory approved by the building official.

- 3. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602 Article 1.6 D. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
- 4. Mortar and Grout Tests: If mortar and grout tests are indicated as required on the Structural drawings, at the beginning of Masonry Work, at least 1 test sample each of mortar and grout shall be taken on 3 successive working days, then once per week with at least one sample taken for each 5000 square feet of wall area, or fraction thereof.
  - a. Test specimens shall be made in accordance with ASTM C1019 for grout and ASTM C780 for mortar.
  - b. Test specimens shall be continuously stored in moist air until tested.
- 5. If masonry placement and grouting inspection is indicated as required on the Structural Drawings, a special inspector shall be employed per CBC Section 1704 during the placement of all units, placement of all reinforcing steel, during all grouting operations and during taking of all test specimens.
- C. Submittals:
  - 1. Mix design for mortar and grout shall be submitted for review.
  - 2. Supplier's certificates indicating materials comply with the specifications below. They shall include but are not necessarily limited to:
    - a. Aggregates
    - b. Cement
    - c. Admixtures

# PART 2 – PRODUCTS

- 2.1 MATERIALS
  - A. Cement: ASTM C150, Type I or II, low alkali; natural gray.
  - B. Hydrated Lime: ASTM C207, Type S.
  - C. Quicklime: ASTM C5.
  - D. Lime Putty: Made from hydrated lime or quicklime.
    - 1. If made from quicklime, other than processed pulverized quicklime, slake lime and then screen through a No. 16 mesh sieve. Before using, store and protect slaked and screened lime putty for not less than 10 days.
    - 2. Processed pulverized quicklime shall be slaked for not less than 48 hours, and shall be cool when used.
    - 3. Lime putty prepared from hydrated lime may be used immediately after mixing.
    - 4. Lime putty prepared from quicklime or pulverized quicklime shall have a plasticity figure, after slaking and screening, of not less than 200, and shall weigh not less than 80 lbs. per cubic foot and not more than 90 lbs. per cubic foot. Lime putty prepared from hydrated lime shall conform to ASTM C207, Type S.

- E. Aggregate:
  - 1. For Mortar: ASTM C144
  - 2. For Grout: ASTM C404
- F. Admixture: "Sika Grout Aid", "BASF MasterPel 240MA"
- G. Water: Suitable for domestic consumption.

## 2.2 MORTAR

- A. Mortar shall be Cement-lime, Type S and shall conform to CBC Section 2103.2.
- B. Mortar shall be made with admixtures that are proportioned, added and mixed in strict accordance with manufacturer's directions. Calcium Chloride cannot be used in mortar mixes.
- C. Refer to architectural drawings for mortar color requirements.

## 2.3 GROUT

- A. Grout shall have a 28-day compressive strength of 2000 psi or f'm, whichever is greater. Grout shall conform to CBC Section 2103.3
- B. Fine Grout or Coarse Grout: The contractor is to determine the proper application of Fine Grout or Coarse Grout based on the grout pour height used and the clear grout space width for multi-wythe construction or clear grout space dimensions for hollow units in accordance with TMS 402 Table 3.2.1.
- C. Add grout admixture in accordance with the manufacturer's recommendations. Calcium Chloride cannot be used in grout mixes.

## PART 3 – EXECUTION

- 3.1 MIXING MORTAR AND GROUT
  - A. Mix mortar and grout in accordance with TMS 602 Articles 2.6A and 2.6B.
  - B. Accurately measure materials in suitably calibrated devices; shovel measurements are not acceptable.
  - C. Place sand, cement and water in mixer in that order and mix for at least 2 minutes; then add lime putty and continue mixing as long as necessary to secure a uniform mass, but in no case less than 10 minutes.
  - D. Use mixers of at least 1 sack capacity; batches requiring fractional sacks will not be permitted unless cement is weighed for each batch.

## 3.2 GROUTING PROCEDURES

- A. Specified under Sections 04 22 00.
- 3.3 RETEMPERING
  - A. When necessary to retemper mortar, add water and remix; retempering by dashing water over mortar will not be permitted.

B. Any mortar which is unused within 2-1/2 hours after initial mixing and any mortar that has begun to set shall not be used.

## 3.4 DEFECTIVE MORTAR OR GROUT

- A. Should the strength of mortar or grout fall below that specified, remainder of Work shall be adjusted to reach required strength. Work in place representing inferior grout and mortar and indicating a strength less than the minimum specified shall be tested by taking and testing core samples. Number and location of cores shall be determined by Structural Engineer.
- B. Should compression tests of cores fail to meet required strength, masonry shall be deemed to be defective and shall be removed and replaced at no cost to Owner.
- C. Costs relative to taking and testing of core samples shall be paid by Owner and will be deducted from Contract Amount. Cost of patching core holes shall be borne by Contractor.

## END OF SECTION

#### SECTION 04 22 00

#### CONCRETE UNIT MASONRY

## PART 1 – GENERAL

#### 1.1 GENERAL REQUIREMENTS

A. The requirements of Division 01 apply to all Work of this Section.

#### 1.2 SCOPE

- A. Furnish and install all concrete unit masonry, reinforcement, and all required accessories and materials as shown on the Drawings and specified here.
  - 1. Cooperate with other trades for embedded items, furnished under those sections and installed here.
  - 2. Supervise setting of dowels for masonry furnished and installed under Section 03 21 00, Reinforcing Steel.
- 1.3 RELATED WORK (See also Table of Contents):
  - A. Reinforcing Steel: Section 03 21 00
  - B. Cast-in-Place Concrete: Section 03 30 00
  - C. Mortar and Grout: Section 04 05 00
  - D. Structural Steel: Section 05 12 00
  - E. Metal Fabrication: Section 05 50 00

#### 1.4 QUALITY ASSURANCE

- A. Allowable Tolerances: Place masonry in accordance with section 3.3B.
- B. Standards and References: (Latest Edition unless otherwise noted):
  - 1. 2019 California Building Code (CBC)
  - 2. TMS 402-16 Building Code Requirements for Masonry Construction
  - 3. TMS 602-16 Specification for Masonry Structures
  - 4. ASTM C90 Specification for Loadbearing Concrete Masonry Units
  - 5. ASTM C140 Standard Test Methods for Sampling and Testing of Concrete Masonry Units and Related Units
  - 6. ASTM C426 Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units
- C. Submittals: Refer to Section 01 33 00 for submitting the following items:
  - 1. Suppliers certificate indicating units comply with material standards indicated below:
  - 2. See Section 03 21 00 for reinforcing steel submittals.

- D. Tests and Inspections:
  - 1. A testing program is required prior to start of construction. Testing program to be done in Compliance with CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 2. All tests and inspections herein are to be performed by an independent testing laboratory approved by the Building Official.
  - 3. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602 Article 1.6 D. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
  - 4. If masonry tests are indicated as required on the structural drawings, three sample units will be tested during construction for each 5,000 square feet of wall area. Test also three sample units prior to construction.
    - a. Units will be tested for compressive strength on both the net and gross area per ASTM C140.
    - b. Units will be tested for linear drying shrinkage per ASTM C426.
  - 5. If masonry placement and grouting inspection is indicated as required on the structural drawings, a special inspector shall be employed per CBC Section 1704 to inspect the placement of all units, placement of all reinforcing steel, during all grouting operations and during taking of all test specimens.
  - 6. See Section 03 21 00 for reinforcing steel tests and inspections.

## 1.5 PRODUCT HANDLING

- A. Scaffolding, runways and ladders required for work under this Section shall be provided by masonry contractor, and shall be heavy trades type substantially built and in compliance with State labor laws, safety codes and other regulatory agencies as applicable to this project.
- B. Store masonry units off the ground in a dry location, covered and protected from absorbing moisture.
- C. Store masonry accessories, including metal items, in such a way as to prevent corrosion or accumulation of dirt and oil.

## PART 2 - PRODUCTS

## 2.1 MASONRY UNITS

- A. Masonry units shall be hollow load bearing masonry units conforming to ASTM C90 and CBC Section 2103.1.
  - 1. Weight: Medium weight
  - 2. Maximum lineal shrinkage from saturated to oven dry condition of not more than 0.065 percent.
  - 3. Twenty-eight day compressive strength of 2000 psi.
  - 4. Moisture controlled units.

- B. Unit Type
  - 1. 8" wide by 8" high x 16" long unless specified otherwise.
- C. Provide bond beam units, open end units, lintel units and other special units as indicated. Use open end units at cells containing vertical reinforcement wherever possible.

## 2.2 MORTAR AND GROUT

A. Specified under Section 04 05 00.

## 2.3 ACCESSORY MATERIALS

- A. Reinforcing Bars: ASTM A615, Grade 40 or 60, as indicated in Section 03 21 00, deformed bars. Where bars are to be welded, ASTM A706 Grade 60 bars shall be used.
  - 1. Tie Wire: Black annealed steel wire not lighter than 16 gauge.
- B. Ladder-type Joint Reinforcing: ASTM A951. Ladder-type joint reinforcing shall be comprised of 9-gauge side rods and 9-gauge cross rods at 16" on center and shall conform to ASTM A951. Crossrods are to be butt welded to side rods. Ladder-type joint reinforcement shall be hot dip galvanized or stainless steel.
  - 1. Width: Fabricate joint reinforcement in units with widths a minimum of 2" less than nominal width of walls. Provide mortar coverage over joint reinforcement of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.
- C. Provide spacers to firmly hold reinforcement in place.
- D. Anchor Bolts: All anchor bolts cast in masonry shall be headed studs or headed bolts with cut threads conforming to ASTM F1554 Grade 36 or ASTM A307 or ASTM A36 as indicated on drawings.
- E. Expansion Anchors: All expansion bolts installed in masonry shall be Hilti Kwik Bolt TZ2 per ICC ESR-4561, Simpson Wedge-All per ICC ESR-1396 or Dewalt/Powers Power-Stud+ SD1 per ICC ESR-2966. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- F. Adhesive Anchors: All drill and epoxy threaded rods shall be ASTM F1554 Grade 36 or Grade 50, as indicated on drawings, and installed in masonry with Hilti HIT-HY 270 per ICC ESR-4143, Simpson SET-XP per UES ER-265 or Dewalt/Powers AC100+ Gold per ICC ESR-3200. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- G. Screw Anchors: All screw anchors installed in masonry shall be Hilti Kwik HUS-EZ per ICC ESR-3056, Simpson Titen HD per ICC ESR-1056 or Dewalt/Powers Screwbolt+ per ICC ESR-4042. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- H. Anchor Finish:
  - 1. Interior Exposure: All anchors, nuts and washers for use in interior environments free of potential moisture shall be manufactured from carbon steel and zinc coated.

- 2. Exterior or Exposed Use: All anchors, nuts, and washers for use in exposed or potentially wet environments, or for attached of exterior cladding materials shall be stainless steel. Stainless steel anchors shall be manufactured from 300 series stainless steel. and nuts and washers from 300 series or Type 18-8 stainless steel.
- G. Non-Metallic Expansion Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D1056, Grade RE 41E1, capable of compression up to 35% of width and thickness indicated.
- H. Premolded Control Joint Strips: Material as indicated below, designed to fit standard sash block and maintain lateral stability in masonry wall; size and configuration as indicated.
  - 1. Premolded PVC Control Joint Strips. Strips shall be polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4 with a durometer hardness or 90.

## 2.4 JOINTS

A. All joints shall be 3/8" thick joints for concrete block. Tool exposed interior and exterior joints and concealed exterior joints to produce a dense slightly concave surface that is well bonded to unit at edges. Tool joints behind room base, switches, and outlet plates to produce a smooth dense joint flush with the face of adjacent masonry units, where occurring on the job. Cut joints flush on concealed interior surfaces and surfaces to be plastered.

## 2.5 SEALER

A. Contractor shall provide and install minimum two coats, BASF MasterProtect H107 masonry sealer, or equal, at all CMU walls. BASF MasterProtect H107 product, or equal, shall meet all state vapor requirements. Sealer shall be clear and non-gloss product.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas to receive masonry and verify following:
  - 1. That foundation surface is level to permit bed joint with range of 1/4 minimum to 3/4 inch maximum for partially grouted or 1-1/4" maximum for fully grouted.
  - 2. That edge is true to line to permit projection of masonry to less than 1/4-inch.
  - 3. That projecting dowels are free from loose scale, dirt, concrete, or other bond-inhibiting substances and properly spaced and located.
- B. Do not begin work before unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Clean concrete surfaces to receive masonry. Remove laitance or other foreign material lodged in surfaces by sandblasting or other means as required. Joints between concrete and masonry shall be considered construction joints. See Concrete specifications.
- B. Ensure masonry units are clean and free from dust, dirt, or other foreign materials before laying. Do not use damaged masonry units, damaged components of structure, or damaged packaged materials.
- C. Establish lines, levels, and coursing. Protect from disturbances.
- D. Provide temporary bracing during erection of masonry work. Maintain in place until masonry has set to provide permanent bracing.

## 3.3 COURSING

- A. Erect masonry in accordance with CBC Section 2104.
- B. Place masonry to lines and levels indicated to the following tolerances:
  - 1. Variation from Unit to Adjacent Unit: 1/32-inch max.
  - 2. Variation from Plane of Wall: 1/4-inch in 10 feet.
  - 3. Variation from Plumb: 1/4-inch in 10 feet; 1/2-inch maximum
  - 4. Variation from Level Coursing: 1/8-inch in 3 feet; 1/4-inch in 10 feet; 1/2-inch maximum
  - 5. Variation of Joint Thickness: 1/8-inch between masonry courses
- C. Bond: Unless noted otherwise in Drawings, lay concrete masonry units in running bond with vertical joints located over score of unit in course below (and vice versa).
- D. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
- E. Preserve the vertical continuity of cells in concrete unit masonry per Article 3.3E of TMS 602.

## 3.4 PLACING AND BONDING

- A. Do not install cracked, broken or chipped masonry units.
- B. Lay only dry concrete masonry units. Do not wet concrete masonry prior to laying up units unless written permission is obtained from the Engineer.
- C. Lay masonry in full bed of mortar, properly jointed with other work. Buttering corners of joints, and deep or excessive furrowing of mortar joints are not permitted.
  - 1. Block Cap: Lay with full mortar coverage on horizontal and vertical joints.
  - 2. Install grout cap where and as indicated.
- D. Fully bond intersections and external and internal corners.
- E. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- F. Remove excess mortar.
- G. Perform job-site cutting with proper tools to provide straight unchipped edges. Take care to prevent breaking masonry unit corners or edges. Install cut units with cut surfaces and, where possible, cut edges concealed.
- H. Step back unfinished work for joining with new work. Do not use toothing.
- I. Provide cleanouts as indicated in "grouting" below.
- J. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing work wherever possible.

## 3.5 JOINTS

- A. Horizontal and vertical joints at masonry units shall be 3/8-inch wide and as follows:
  - 1. Point joint tight in unpurged masonry below ground.
  - 2. All end joints shall be fully filled with mortar and joints squeezed in bed joints shall be held back approximately 1/2-inch from cell to provide positive bond with grout.
  - 3. Joints shall be struck flush at all areas to receive plaster, stucco and any other finish material other than paint.

#### 3.6 MASONRY REINFORCEMENT

- A. Place reinforcement in accordance with Article 3.4 B of TMS 602.
- B. Reinforcing steel shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the plans shall not be used. Heating of bars for bending is not permitted.
  - 1. Bars shall conform accurately to the sizes, shapes, lines and dimensions shown on drawings and with hooks and beds made as detailed. Bars shall be placed as indicated on the drawings and centered on grout space.
  - 2. At the time grout is place around it, reinforcing steel shall be clean of mill scale or other coatings that will destroy or reduce bond.
  - 3. All vertical reinforcing steel shall be installed in one piece whenever practical, full height of wall, and braced throughout its height in a manner that will retain the steel in proper position and provide the proper clearance.
- C. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 in of vertical height.
- D. Reinforcing steel shall be secured to all foundation dowels and held in place at spacing not to exceed 192 bar diameters.

## 3.7 GROUTING

- A. General Requirements:
  - 1. All cells shall be grouted solid.
  - 2. Use of grout lifts above or below 5 feet 4 inches at Contractor's option.
  - 3. Use grout pump, hopper or bucket to place grout.
  - 4. Place grout in final position within 1-1/2 hours after introduction of mixing water.
  - 5. Stop grout approximately 1 1/2 inches below top of last course; except at top course bring grout to top of wall. Do not form grout keys within beams.
- B. Grout pours 5 feet 4 inches or less:
  - 1. Do not lay units higher than 64 inches before grouting.
  - 2. If mortar has been allowed to set prior to grouting, remove all fins protruding more than 1/2-inch into grout space.

- 3. Consolidate each lift with mechanical vibration twice per Article 3.5 E of TMS 602. Once while placing grout and once more after initial absorption of water but before set.
- C. Grout pours greater than 5 feet 4 inches:
  - 1. Layup walls, subject to maximum height limitations of Table 6 under Article 3.5 of TMS 602.
  - Provide clean out holes at the bottom of every pour in cells containing vertical reinforcement. Construct clean out courses with open-bottom bond beam units inverted to permit cleaning of all cells by flushing. Cleanouts shall be not less than 3x4inch openings cut from one face shell. Do not plug clean out holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected.
  - 3. Clean mortar droppings from the bottom of the grout space and from reinforcing steel. Remove mortar fins protruding more than ½-inch into the grout space by dislodging the projections with a rod or stick as the work progresses or by washing the grout space at least twice a day during erection using a high-pressure stream of water.
  - 4. Do not place grout in hollow unit masonry until mortar joints have set for at least 24 hours and clean out plugs have cured 24 hours.
  - 5. Place grout in lifts not to exceed 12 feet 8 inches in height, with a waiting period between lifts, dependent on weather and absorption rate of the masonry, in order to place the succeeding lift after the preceding lift becomes plastic but prior to initial set. The first lift shall be consolidated using mechanical vibrators. After the required waiting period, place the second lift and consolidate with the vibrator, reconsolidating the lift below to a depth of 12 to 18 inches. Repeat the waiting, placing and consolidating process until the top of the grout pour is reached. Reconsolidate the top lift after the required waiting period. The high-lift grouting of any section of wall between lateral flow barriers shall be completed to the top of a pour in one working day unless a new series of clean out holes is established and the resulting horizontal construction joint cleaned.

## 3.8 WEATHER PROVISIONS FOR CONSTRUCTION

- A. Cold Weather Construction to be in accordance with Article 1.8 C of TMS 602.
- B. Hot Weather Construction to be in accordance with Article 1.8 D of TMS 602.
- 3.9 EXPANSION AND CONTROL JOINTS
  - A. See drawings for type and location of expansion and/or control joints.
  - B. Where control joints are not indicated on the drawings the Contractor shall submit a proposed control joint layout for Architect and Engineer approval. General guidelines for control joint locations are as follows:
    - 1. At major changes in wall height
    - 2. At changes in wall thicknesses
    - 3. At corresponding control joints in foundations, floors, or roof construction
    - 4. Near wall intersections
    - 5. At column centerlines

C. Maximum Spacing: Maximum control joint spacing in concrete masonry construction shall be such that the ratio of wall length to height shall not exceed 1.5 with a maximum spacing of 25 feet.

## 3.10 BOND BEAMS

A. Bond beams shall be located where shown and detailed on the drawings, and shall be reinforced as indicated and as herein after specified.

## 3.11 BUILT-IN WORK

A. Miscellaneous Embedded Items: All items indicated to be embedded in masonry shall be carefully located and anchored to prevent movement during grouting operations. Solidly grout spaces around built-in items. Consult other trades in advance and make provisions for installation of their work to avoid cutting and patching. Install chases minimum of one full masonry unit length for jambs.

## 3.12 CUTTING AND FITTING

A. Obtain approval prior to cutting or fitting any area not indicated or where appearance or strength of masonry work may be impaired.

#### 3.13 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damage, or if units do not match adjoining units.
- B. Pointing: During the tooling of joints, enlarge any voids or holes and completely fill with mortar.
- C. Dry brush masonry surface after mortar has set, at each day's work and after final pointing.
- D. Leave work and surrounding surface clean and free of mortar spots and droppings.
- E. Cleaning: Upon completion of masonry installation, repair all holes. Defective joints shall be cut out and rejointed. Exposed masonry surfaces shall be cleaned free of mortar, green stain and efflorescence.

## 3.14 SEALER

A. Contractor shall install sealer as directed by the manufacturer. Coverage and installation rates shall be as per manufacturer's recommendations. Install sealer in minimum two coats at the rates required.

#### 3.15 DEFECTIVE MASONRY

- A. Materials or workmanship not conforming to appearance or strength specified, will be deemed defective and shall be removed and replaced at no cost to Owner.
- B. Defective mortar and grout, as defined under Section 04 05 00; "Mortar and Grout" shall constitute defective masonry.

END OF SECTION

# SECTION 05 05 19

## POST-INSTALLED CONCRETE ANCHORS

## PART 1 – GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. Requirements of Division 01 apply to all work of this section.
- 1.2 SCOPE
  - A. Design, furnish, and install concrete anchors as indicated on drawings and specified herein.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 05 12 00 Structural Steel
  - B. Section 05 50 00 Metal Fabrications
  - C. Section 06 10 00 Rough Carpentry
  - D. Section 07 60 00 Flashing and Sheet Metal
  - E. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Drilled-in anchors shall be installed by an installer with at least five years of experience performing similar installations.
  - 2. Adhesive anchor installers shall be certified in accordance with the ACI- CRSI Adhesive Anchor Installer Certification Program.
- B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
  - 1. Hole drilling procedure
  - 2. Hole preparation & cleaning technique
  - 3. Adhesive injection technique & dispenser training / maintenance
  - 4. Rebar dowel preparation and installation
    - a. Proof loading/torqueing per the contract drawings and applicable ICC ESR requirements
  - 5. Certifications: Unless otherwise authorized by the Engineer, anchors shall have the following certification: ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.
- C. Submittals: (Submit under provisions of Section 01 33 23)

- 1. Product specifications with recommended design values and physical characteristics for epoxy dowels, expansion, and undercut anchors.
- 2. Samples: Representative length and diameters of each type anchor shown on the Drawings.
- 3. Quality Assurance Submittals:
  - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
  - b. Certificates:
  - c. ICC ES Evaluation Reports
- 4. Manufacturer's installation instructions
- 5. Installer Qualifications & Procedures: Submit installer qualifications as described herein and on the drawings. Submit a letter of procedure stating method of drilling, the product proposed for use, and the complete installation procedure including the steel reinforcement detection system.
- D. Closeout Submittals: Submit the following:
  - 1. Record Documents: Project record documents for installed materials in accordance with Division 01 Closeout Submittals Section.
- 1.5 DELIVERY, STORAGE AND HANDLING:
  - A. General: Comply with Division 01 Section—Product Storage and Handling Requirements.
  - B. Store anchors in accordance with manufacturer's recommendations.

## PART 2 - PRODUCTS

- 2.1 MATERIALS
  - A. Products and materials as indicated on the drawing general notes and details.
  - B. Expansion Anchors:
    - Wedge Anchors: Anchors shall meet the physical requirements of Federal Specification A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with a single piece steel expansion clip providing 360-degree contact with the base material and shall not require oversized holes for installation. Carbon steel anchors shall have an electroplated zinc finish or shall be mechanically galvanized in accordance with ASTM B695, Class 55, Type 1, as appropriate. Anchors shall have an evaluation report issued by ICC-ES and have been tested in accordance with ICC-ES AC01 for all mandatory tests and including the following:
      - a. At exterior locations, wet locations, or in freezer/cooler locations, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener.
- b. Seismic tension & shear
- b. Combination of tension and shear loads
- c. Critical and minimum edge distance
- d. Unless otherwise noted, wedge anchors shall comply with ICC-ES ESR-1396 or be equal in testing standards.
- 2. Sleeve Anchors: Anchors shall meet the physical requirements of Federal Specification A-A-1922A. Anchors shall be non-bottom bearing type with a single piece steel expansion sleeve providing 360-degree contact with the base material and shall not require oversized holes for installation. Carbon steel anchors shall have an electroplated zinc finish. Anchors shall have been tested in accordance with ICC-ES AC01 for the following:
  - a. At exterior locations, wet locations, or in freezer/cooler locations, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener.
  - b. Static Loads
  - b. Critical and minimum edge distance and spacing
- 4. Flush-Mount, Internally Threaded Shell Anchor: Anchors shall meet the physical requirements of Federal Specification A-A-55614, Type I. Anchors shall be bottom-bearing type with a slotted single piece steel shell and a tapered expander plug providing 360-degree contact with the base material. Carbon steel anchors shall have an electroplated zinc finish. At exterior locations, use stainless steel anchors of type 316. Anchors shall have been tested in accordance with ICC-ES AC01 for all mandatory tests and including the following:
  - a. Seismic tension and shear
  - b. Combination of tension and shear loads
  - c. Critical and minimum edge distance and spacing
- C. Adhesive Anchors:
  - 1. Cracked Concrete Epoxy Adhesives: Anchors used to transmit load 1) between structural elements and/or 2) from life safety-related attachments, shall be designed in accordance with ACI 318 Appendix D as amended by the specific design provisions of ICC-ES AC308. Adhesives shall be a cartridge type, two-component, high solids epoxy based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. The adhesive shall meet the minimum requirements of ASTM C-881 Type I and IV, Grade 3, Class C. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Epoxy adhesives shall have an evaluation report issued by ICC-ES and have been tested and qualified for use in cracked and uncracked concrete in accordance with ICC-ES AC308 for all mandatory tests and including the following:
    - a. Seismic tension and shear in cracked concrete

- b. Static and cyclic cracks
- c. Horizontal and overhead installations
- d. Long term creep at elevated temperatures
- e. Damp holes
- f. Freeze-thaw conditions
- g. Critical and minimum edge distance and spacing
- h. Unless otherwise notes, cracked concrete epoxy adhesives shall comply with ICC-ES ESR-2508 or be equal in testing standards.
- 2. Epoxy Adhesives: Adhesives shall be a cartridge type, two-component, solid epoxy based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. The adhesive shall meet the minimum requirements of ASTM C-881 Type I, II, IV and V, Grade 3, Class B and C. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Epoxy adhesives shall have an evaluation report issued by ICC-ES and shall have been tested in accordance with ICC-ES AC58 for all mandatory tests and including the following:
  - a. Seismic tension and shear
  - b. Long term creep at elevated temperatures
  - c. Static loading at elevated temperatures
  - d. Damp and water-filled holes
  - e. Freeze-thaw conditions
  - f. Critical and minimum edge distance and spacing
  - g. Unless otherwise noted, epoxy adhesives shall comply with ICC-ES ER-4945 or ICC-ES ESR-1772 or be equal in testing standards.
- 4. Adhesive Limitations:
  - a. Installation Temperature: When the base material temperature drops below 40-degrees F (5-degrees C), only Acrylic or Encapsulated Adhesives shall be used for adhesive installations. See manufacturer's instructions for additional minimum temperature requirements.
  - Hollow Substrates: The adhesive manufacturer's screen tubes shall be used for adhesive installations into hollow substrate material. Encapsulated Adhesives shall not be used in hollow substrate applications.
  - c. Moisture: Encapsulated Adhesives shall not be used when moisture is present in or around hole.
  - d. Oversized Holes: Refer to manufacturer's information if drilled hole size is larger than what is recommended.
  - e. Core-drilled holes: Refer to manufacturer's information if holes are drilled with a core-drill bit.

- D. Concrete and Masonry Screw Anchors:
  - Cracked Concrete Screw Anchors: Anchors used to transmit load 1) between structural elements and/or 2) from life safety-related attachments, shall be designed in accordance with ACI 318 Appendix D as amended by the specific design provisions of ICC-ES AC193. Anchors shall be manufactured from carbon steel which is subsequently heat-treated. Anchors shall be zinc-plated in accordance with ASTM B633, Class SC1, Type I. Anchors shall have an evaluation report issued by ICC-ES and have been tested in accordance with ICC-ES AC193 for all mandatory and including the following:
    - a. Seismic tension and shear
    - b. Reliability of screw anchors against brittle failure
    - c. Unless otherwise noted, cracked concrete screw anchors shall comply with ICC-ES ESR-2713 or ICC-ES ESR-2713 or be equal in testing standards.
  - 2. Masonry Screw Anchors: Anchors shall have 360-degree contact with the base material and shall not require oversized or undersized holes for installation. Anchors shall be manufactured from carbon steel which is subsequently heat-treated. Anchors shall be zinc-plated in accordance with ASTM B633 or mechanically galvanized in accordance with ASTM B695. Anchors shall have an evaluation report issued by ICC-ES and have been tested in accordance with ICC-ES AC106 for the following:
    - a. Seismic tension and shear
    - b. Static tension and shear loading
    - c. Critical and Minimum edge distance and spacing
    - d. Unless otherwise noted, concrete and masonry screw anchors shall comply with ICC-ES ESR-1056 or be equal in testing standards.
  - 3. High strength, heat-treated anchors are recommended for permanent dry, interior non-corrosive applications or temporary outdoor applications.
- E. Powder Actuated Fasteners:
  - 1. Fasteners are manufactured from steel complying with ASTM A 510, Grades 1060 to 1065 or 10B60 to 10B65 and austempered to a Rockwell "C" core hardness of 51 to 56, except for PDPA headed fasteners. PDPA headed fasteners are manufactured from steel complying with ASTM A 510, Grade 1060, and austempered to a Rockwell "C" core hardness of 53 to 56. Unless otherwise noted in the evaluation report, the fasteners have a mechanically plated zinc finish complying with ASTM B 695, Type I, Class 5. When installed with the powder actuated fastening tool recommended by Simpson Strong-Tie, the fasteners must pierce the material being fastened and embed into the supporting concrete, structural steel or CMU substrate. Fasteners shall have an evaluation report issued by ICC-ES and have been tested in accordance with ICC-ES AC70.
  - 2. Unless otherwise noted, powder actuated fasteners shall comply with ICC-ES ESR-2138 or be equal in testing standards.

- F. Anchor Sizes:
  - 1. The anchor size (nominal diameter and embedment depth) shall be as indicated on the Contract Drawings. If not indicated on the drawings, sizes shall be provided as required to maintain not less than the appropriate Code safety factors over manufacturer's performance load tables. If the actual concrete compressive strength is not known, the compressive strength shall be determined through testing.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Drilled-In Anchors:
  - Drill holes with rotary drills using carbide-tipped bits, and core drills using diamond core bits. Use of core drills is only acceptable where specifically allowed by the applicable ICC ESR requirements. Drill bits shall be of diameters as specified by the anchor or the adhesive manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
    - a. Cored Holes: Where anchors are to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Roughen holes to manufacturer recommended surface.
    - b. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 2. Perform anchor installation in accordance with manufacturer instructions.
  - 3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
  - 4. Cartridge Injection Adhesive Anchors: Follow ICC ESR requirements without exception. Unless contrary to the ICC ESR requirements, perform the following measures: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Holes may be dry, damp or wet. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected into the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
  - 5. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

# 3.2 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

# SECTION 05 12 00

# STRUCTURAL STEEL

# PART 1 - GENERAL

# 1.1 GENERAL REQUIREMENTS

A. Requirements of Division 01 apply to all Work of this Section.

# 1.2 SCOPE

- A. Furnish and install all structural steel as shown and specified including, but not necessarily limited to the following:
  - 1. Prime coat painting and touch up
  - 2. All cast-in-place anchor bolts, nuts, plates, etc.
  - 3. 10-gauge steel or 3/4-inch plywood templates for column anchor bolts
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 03 30 00 Cast-In-Place Concrete
  - B. Section 05 30 00 Metal Decking
  - C. Section 05 50 00 Metal Fabrications
  - D. Section 09 97 13 Steel Coatings
  - E. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

#### 1.4 QUALITY ASSURANCE

- A. General:
  - 1. Comply with the referenced ASTM standards for materials
  - 2. Perform all welding only with AWS certified welders
  - 3. Verification of accuracy:
    - a. Engage and pay for a registered civil engineer or licensed land surveyor to check the alignment, plumbness, elevation, and overall accuracy of the erected framing at appropriate stages during construction and at completion of erection. Prior to erection, a survey shall be made of the as-built locations of all anchor rods and other embedded items associated with the attachment of structural steel. The party providing the survey shall submit written verification that the entire installation is in accordance with the contract documents and meets the allowable erection tolerances as set forth in the AISC "Code of Standard Practice for Steel Buildings and Bridges".
    - b. Columns shall be verified at each lift. Column shim details and procedures shall be submitted for review.
  - 4. Paint:

- a. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use thinners approved by paint manufacturer, and use within recommend limits.
- b. Coordination of Work: Review other Sections in which prime paints are to be provided to ensure compatibility of coatings system for various substrates. Upon request, furnish information or characteristics of finish materials to be used.
- c. Requirements of Regulatory Agencies: Comply with applicable rules and regulations of governing agencies for air quality control.
- B. Except where other requirements are specified, comply with the following standards (latest edition unless noted otherwise)
  - 1. AISC 360 "Specification for Structural Steel Buildings"
  - 2. AISC 303 "Code of Standard Practice for Steel Buildings and Bridges"
  - 3. AISC 341 "Seismic Provisions for Structural Steel Buildings"
  - 4. AISC 358 "Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications"
  - 5. RCSC "Specifications for Structural Joints Using High Strength Bolts"
  - 6. AISC 303 Section 10, Architecturally Exposed Structural Steel, Code of Standard Practice for Steel Buildings and Bridges
  - 7. AWS D1.1 "Structural Welding Code Steel" latest edition
  - 8. AWS D1.8 "Structural Welding Code Seismic Supplement" latest edition
  - 9. ASTM A6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use"
  - 10. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
  - 11. SSPC-SP2 Hand Tool Cleaning
  - 12. SSPC-SP3 Power Tool Cleaning
  - 13. SSPC-SP6 Commercial Blast Cleaning
  - 14. SSPC-PA2 Measurement of Dry Paint Thickness with Magnetic Gauges
  - 15. California Building Code (CBC) latest edition
- C. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Product Data: Include laboratory test reports and other data to show compliance with specifications (include specified standards). Include certified copies of mill reports covering chemical and physical properties of each type of structural steel.
  - 2. Shop Drawings:

- a. Shop drawings shall include complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
- b. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.
- c. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
- Dimensions required to locate structural steel for manufactured items such as mechanical equipment, electrical equipment, dock levelers, etc., shall be coordinated and provided by the Contractor. Contractor shall also coordinate and provide dimensions to locate structural steel for window washing supports such as davits, tie-backs, etc.
- 3. Procedures:
  - a. Provide weld procedures for both prequalified welds and special welds to be submitted to the Owner's Testing Laboratory and the Architect.
  - b. Provide installation procedure and inspection for direct tension indicator washers detailed in supplemental specifications provided by the manufacturer for approval.
  - c. Procedures shall be submitted for both shop and field welds.
- 4. Buy Clean California Reporting: (Submit under provisions of Section 01 33 29.08)
  - a. Provide an Environmental Product Declaration (EPD) for each mill producing eligible Structural Steel material proposed to be used on the Project. Structural Steel products to include: W-, S-, M- and HP- shapes, channels, angles, split tees, plate and round, square and rectangular ASTM A500, A847 and A1085 HSS essential to support the design loads of a structure. The following products do not require EPD's: metal buildings, steel joists, sheet and bearing piles, guard rail, light poles, cold-formed steel products, pressure vessels, crane rails, handrails, stairs and other items detailed in the AISC Code of Standard Practice (ANSI/AISC 303) Section 2.2.
  - b. Thresholds: EPD's for eligible steel products must document that GWP-100 levels do not exceed the following thresholds:

Category	Product	GWP-100 Threshold at Mill Gate as published by DGS (1)	GWP-100 Threshold if U.S. industry average fabrication is included (2)
Structural Steel	Hot-rolled structural sections	1.01 tons/ton	1.22 tons/ton
	Hollow structural sections	1.71 tons/ton	1.99 tons/ton
	Plate	1.49 tons/ton	1.73 tons/ton

(1) Use this column to determine compliance when an EPD declares mill-only material (cradle to mill gate).

- (2) Use this column to determine compliance when an EPD declares mill material plus U.S. industry average fabrication impacts (cradle to fabricator gate).
- D. Tests and Inspections:
  - 1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
  - 2. Testing Laboratory:
    - a. All materials, work, methods and equipment shall be subject to inspection at the mill, fabricating plant and at the building site. Material or workmanship not complying fully with the Contract Documents will not be accepted. The Contractor shall give the Testing Laboratory reasonable notice when ready for inspection and shall supply samples and test pieces and all facilities for inspection without extra charge. The Owner will assume the expense of making the tests and inspection except as otherwise specified in Division 01.
  - 3. Cost of Testing and Inspection: Costs of testing and inspection of structural steel, except as specified hereunder and in Division 01, will be paid for by the Owner.
    - a. All transportation costs and per diem living costs for inspection at fabricators' plant further than 75 miles from the job site will be back-charged to the Contractor.
    - b. It is assumed that all fabrication will take place in one shop location only. All additional inspection costs will be back-charged to the Contractor.
    - c. All mill tests and costs of re-test of plain materials shall be at the expense of the Contractor.
    - d. Costs of tests required due to Contractor's failure to provide steel identifiable in accordance with the indicated ASTM designation shall be at the expense of the Contractor.
  - 4. Structural Steel Testing and Inspection:
    - a. Structural Steel: If structural steel tests are indicated as required on the structural drawings, one tension and one bend test shall be made for each size of structural shape, plate and for each tube and pipe size. Tests to be made in accordance with requirements of appropriate ASTM designations.
    - b. If structural steel tests are not indicated as required on the structural drawings, then for shapes, plates, bars, pipe and tubing, manufacturer's certified mill test reports and analysis for each heat will be acceptable for steel identifiable in accordance with indicated ASTM designation. Mill test reports shall indicate the physical and chemical properties of all structural steel used. Correlate individual heat numbers with each specified structural section.
    - c. Unidentifiable Steel:

- 1) For Fy less than or equal to 36.0 ksi: Provide one tension and elongation test and one bend for each 5 tons or fraction thereof for each size.
- 2) For Fy greater than 36.0 ksi: Provide one tension and elongation test and one bend or flattening for each piece.
- d. Costs of retests and additional testing required by the use of unidentifiable steels shall be the Contractor's responsibility. Additional costs of testing incurred by the Owner shall be deducted from the Contract Final Payment.
- 5. Expansion Anchors: Load test as indicated on drawings.
- 6. Welding Inspection:
  - a. For Moment Resisting Frame Welding inspection and testing requirements, see specification Section 05 12 24 Welding of Moment Resisting Frames.
  - b. If shop or field welding inspection is indicated on the structural drawings or required by the applicable referenced standards, shop and field welded operations shall be inspected in accordance with AISC 360 by a qualified welding inspector employed by the Testing Laboratory. Such inspector will be a person trained and thoroughly experienced in inspection of welds. The inspector's ability to distinguish between sound and unsound welding will be reliably established
  - c. The welding inspector will make a systematic record of all welds. This record shall include:
    - 1) Identification marks of welders
    - 2) List of defective welds
    - 3) Manner of correction of defects
  - d. The welding inspector will check the material, equipment and procedure, as well as the welds. He will also check the ability of the welder. He will furnish the Architect with a report, duly verified by him that the welding which is required to be inspected is proper, and has been done in conformity with the Contract Documents, and that he has used all means to determine the quality of the welds.
  - e. All full penetration groove welds will be subject to ultrasonic testing, as per AWS D1.1. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.
  - f. Column Flanges: An area extending 6 inches above and below point where girder flanges are attached will be inspected. Column flange edges will be inspected visually and entire area ultrasonically for lamination, plate discontinuities, and non-metallic inclusions.
  - g. When ultrasonic indications arising from the weld root can be interpreted as either a weld defect or the backing strip itself, the Engineer will be notified. The Engineer may require the removal of backing strip. The backing strip will be removed at the expense of the Contractor, and if no root defect is visible the weld will be retested. If no defect is indicated on this retest, and no significant amount of base and weld metal have been

removed, no further repair of welding is necessary. If a defect is indicated, it will be repaired and retested at Contractor's expense.

- h. The ultrasonic instrumentation will be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1.
- i. Other methods of inspection, for example, X-Ray, gamma ray, magnetic particle, or dye penetrant, may be used on welds if felt necessary by the inspection laboratory, and with the approval of the Engineer.
- j. Base metal thicker than 1-1/2 inches, when subjected to through thickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities directly behind such weld before and after joint completion.
- k. End-welded studs shall be sampled, tested, and inspected per the requirements of AWS D1.1.
- I. At the discretion of the owner's testing agency, the ultrasonic testing frequency may be reduced but may not be less than the following:
  - 1) Initially, all welds requiring ultrasonic testing will be tested at the rate of 100 percent in order to establish the qualifications of each individual welder. If the reject rate is demonstrated to be less than 5 percent of the welds tested for each welder, then the frequency of testing for that welder may be reduced to 25 percent. If the reject rate increases to 5 percent or more, 100 percent testing will be re-established until the rate is reduced to less than 5 percent. The percentage of rejects will be calculated for each welder independently.
  - 2) A sampling of a least 40 completed welds will be made for such reduction evaluation. Reject rate is defined as the number of welds containing rejectable defects divided by the number of welds completed. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is 1" or less, each 12 inch increment or fraction thereof shall be considered as one weld. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is greater than 1", each 6 inch of length or fraction thereof shall be considered one weld.
- 7. High Strength Bolting Tests and Inspection:
  - a. Furnish certified test reports for each lot of bolts in accordance with of ASTM A325 and A490. Install bolts under the supervision of a qualified inspector in accordance with, Research Council "Specifications for Structural Joints using ASTM A325 or A490 Bolts".
  - b. If high strength bolting inspection is indicated on the structural drawings or required by the applicable referenced standards, the testing laboratory shall provide inspection in accordance with AISC 360.
  - c. While the work is in progress, the Inspector shall determine that the requirements of this Specification are met in the work. The Inspector shall observe the calibration procedures and shall monitor the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts.

- In addition to the requirement of the foregoing paragraph, for all connections specified to be slip critical (SC), the Inspector shall assure that the specified procedure was followed to achieve the pretension specified in the AISC. The pretension shall be verified by the inspector for these bolts.
- 2) Bolts in connections identified as not being slip-critical nor subject to direct tension need not be inspected for bolt tension other than to ensure that the piles of the connected elements have been brought into snug contact.

#### 1.5 PRODUCT HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
- B. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

#### 1.6 SEQUENCING/SCHEDULING

A. Cooperate and coordinate this work with other trades for anchor bolts, and other required inserts, templates, etc. Align this work prior to installation of other materials.

# PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Structural Steel: Except where indicated on drawings
  - 1. W shapes: ASTM A572-50 or ASTM A992-50 unless indicated otherwise on drawings.
  - 2. Channels and other rolled shapes: ASTM A36 unless indicated otherwise on drawings.
  - 3. Angles, plates and bars: ASTM A36 unless indicated otherwise on drawings.
- B. AISC group 4 and 5 shapes and plates greater than 2 inches thick: ASTM A36 and/or ASTM A572 Grade 50 with supplementary requirements S91 Fine Austenitic Grain Size and S5 Charpy V-Notch Impact Test. For location of Charpy V-Notch test, see ASTM A6 Supplementary Requirement S30. Charpy V-Notch test shall be per ASTM A673, frequency P and shall meet a minimum average value of 20 ft-lbs absorbed energy at 70° F.
- C. Cold-Formed Steel Tubing: ASTM A500, Grade C
- D. Steel Pipe: ASTM A53, Type E or S, Grade B
- E. Anchor Bolts: All anchor bolts cast in concrete or masonry shall be headed bolts with cut threads conforming to ASTM F1554 grade 36, 55 (weldable per S1 Supplementary Requirements), or 105 as indicated on drawings.
- F. Machine Bolts: ASTM A307

- G. High Strength Bolts, Nuts and Washers: Install in accordance with requirements for A325 and A490 slip critical and snug tight conditions as indicated on drawings. Install high strength bolts with snug tight type connections with threads included in shear plane except as otherwise noted. Install hardened washers in conformance with AISC Specifications.
  - 1. Bolt Specifications: Bolts shall conform to the requirements of the current edition of the Specifications of the American Society for Testing and Materials for High-Strength Bolts for Structural Steel Joints, ASTM A325, Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength, ASTM A490 as indicated on drawings.
  - 2. Bolt Geometry: Bolt dimensions shall conform to the current requirements of the American National Standards Institute for Heavy Hex Structural Bolts, ANSI Standard B18.2.1. The length of bolts shall be such that the end of the bolt will be flush with or outside the face of the nut when properly installed.
  - Nut Specifications: Nuts shall conform to the current chemical and mechanical requirements of the American Society for Testing and Materials Standard Specification for Carbon and Alloy Steel Nuts, ASTM A563, Appendix Table X1.1. Provide Grade A Heavy Hex nuts for Grade 36 and 55 threaded rods. Provide Grade DH or ASTM A194-2H Heavy Hex nuts for Grade 105 threaded rod.
  - 4. Washers: Flat circular washers and square or rectangular beveled washers shall conform to the current requirements of the American Society for Testing and Materials Standard Specification for Hardened Steel Washers, ASTM F436. Washers for base plates shall be placed top and bottom of plate and shall be ASTM A36 square or circular unless ASTM F844 are permitted on the drawings.
  - 5. Tension Control Fastener System: Bolts shall conform to the requirements of the current edition of the Specifications of the American Society for Testing and Materials for Twist Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, ASTM F1852, providing equivalent properties to ASTM A325 or A490 as indicated on drawings.
- H. Headed Stud-Type Shear Connectors: ASTM A29-12, Grade 1010 through 1020, colddrawn carbon steel with dimensions complying with AISC Specifications, with minimum physical properties as follows:
  - 1. Ultimate Tensile strength: 65,000 psi
  - 2. Yield strength 0.2% offset: 51,000 psi
  - 3. Elongation in 2 inches: 20 percent
  - 4. Reduction of area: 50 percent
- I. Provide hexagonal heads and nuts for all connections per ASTM A563, Appendix Table X1.1.
- J. Electrodes for Welding: Comply with AWS Code, E70 Series minimum. Fabricator to select proper electrodes according to weld procedures as submitted.
- K. Shop Primer See Section 3.4, Painting and Cleaning
- L. Powder Driven Fasteners (Shot Pins): Tempered steel pins with special corrosive resistant plating or coating. Pins shall have guide washers to accurately control

penetration. Fastening shall be accomplished by low-velocity piston-driven power activated tool. Pins and tool shall be as manufactured by Hilti Fastening Systems.

M. Expansion Bolts: Refer to Section 05 05 19 Post-Installed Concrete Anchors.

# PART 3 - EXECUTION

- 3.1 FABRICATION
  - A. Shop Fabrication and Assembly: Fabricate and assembly structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated to provide the flattest floor possible. The contractor shall coordinate member tolerances with finishes.
    Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
  - B. Connections: Weld or bolt shop connections, as indicted. Bolt field connections, except where welded connections or other connections are indicated.
  - C. Unless noted otherwise, make holes 1/16 inches larger than the nominal bolt diameter.
  - D. Welding, Shop and Field: Weld by shielded arc method, submerged arc method, flux cored arc method, or other method approved by AWS. Perform welding in accordance with AWS Code. All welders, both manual and automatic, shall be certified in accordance with AWS "Standard Qualification Procedure" for the Work to be performed. See paragraph "welding" herein, for detailed requirements. If sizes of fillet welds are not shown on drawings, use AWS minimum weld size but not less than 3/16 inch fillet welds.
  - E. Bolt Holes for Other Work: Provide holes required for securing other work to structural steel framing.
    Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.
    Cut, drill, or punch holes perpendicular to metal surfaces and remove all burrs. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
  - F. AISC Group 4 and 5 shapes and built up members shall meet the requirements for joints in AISC Sections J1.5, J1.6, J2.7 and M2.2.
  - G. High Strength Bolts:
    - 1. Installation and Tightening:
      - a. Handling and Storage of Fasteners: Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.
      - Tension Calibrator: A tension measuring device shall be required at all job sites where bolts in slip-critical joints are being installed and tightened. The tension measuring device shall be used to confirm: (1) the suitability to satisfy the requirements of AISC for the complete fastener assembly, including lubrication if required to be used in the work, (2) calibration of wrenches, if applicable, and (3) the understanding

and proper use by the bolting crew of the method to be used. The frequency of confirmation testing, the number of tests to be performed and the test procedure shall be as specified in 1.d. below, as applicable. The accuracy of the tension measuring device shall be confirmed through calibration by an approved testing agency at least annually.

- c. Joint Assembly and Tightening of Shear/Bearing Connections: Bolts in connections not within the slip-critical category shall be installed in properly aligned holes, but need only be tightened to the snug tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. If a slotted hole occurs in an outer ply, a flat hardened washer or common plate washer shall be installed over the slot.
- d. Joint Assembly and Tightening of Connections Requiring Full Pretensioning. Slip-critical connections shall be installed in properly aligned holes and tightened by one of the following methods.
  - 1) Turn-of-nut Tightening: When turn-of-nut tightening is used, hardened washers are not required except as specified in the AISC. A representative sample of not less than three bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension. The test shall demonstrate that the method of estimating the snug-tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than five percent greater than the tension required for slip-critical connections.
  - 2) Installation of Alternate Design Bolts: A representative sample of not less than three bolts of each diameter, length and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers. if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each bolt develops a tension not less than five percent greater than the tension required by AISC. Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and in all connections. When alternate design features of the fasteners involve an irreversible mechanism such as yield or twist-off of an element, bolts shall be installed in all holes of the connection and initially brought to a snug tight condition. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners prior to final twist-off or vielding of the control or indicator element of the individual fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic tightening.
- e. Mark bolts that have been completely tightened with an identifying symbol.

# 3.2 WELDING

A. General: Quality of materials and design and fabrication of all welded connections shall conform to AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Building", "AWS Code for Welding in Building Construction", and requirements

of this section. Where members and connections are noted in the construction documents as being part of the seismic lateral force resisting system (LFRS), the requirements of AWS D1.8 Structural Welding Code – Seismic Supplement shall apply. Location and type of all welds shall be as shown. Make no other welded splices, except those shown on drawings, without prior approval of the architect.

- B. Automatic Welding: Use electrode wire and flux for automatic and semi-automatic welding acceptable to Structural Engineer. All methods, sequences, qualification and procedures, including preheating, and post heating if necessary, shall be detailed in writing and submitted to the Structural Engineer for review.
- C. Qualification of Welders:
  - 1. Structural steel welding: Manual and automatic welds for structural steel construction shall be made only by operators who have been previous qualified by tests, as prescribed in AWS D1.1 to perform type of work required.
  - 2. Welders shall be checked by welding inspector. Those not doing satisfactory work may be removed, and may be required to pass qualification tests again. All qualification testing shall be at the Contractor's expense.
  - 3. Only welders whose weld procedures and pre-qualification by testing that have passed shall be considered qualified for such welds.
- D. Control cooling process after weld is completed by either step down post heat or thermal blankets as determined by procedures and prequalification.
- E. Box columns and built-up members shall have ultrasonic testing before and after welding.
- F. Flame cut surfaces shall be ground to remove contaminated steel layer to provide welds proper fusion without impurities.
- G. Preparation of surface: Surfaces to be welded shall be free of loose scale, slag, rust, grease, paint, and any other foreign material.
- H. Welding equipment: Welding equipment to be used in each case shall be acceptable to welding inspector. Use equipment with suitable devices to regulate speed, and manually adjust operating amperage and voltage. The amperage capacity shall be sufficient to overcome line drop, and to give adequate welding heat.
- I. Remove runoff tabs and grind surfaces smooth where the tabs would interfere with fireproofing and architectural finishes.
- J. End-welded studs:
  - 1. Automatic end-welded studs: Automatically end-weld in accordance with the manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and the plates. There shall be no porosity or evidence of lack of fusion between the welded end of the stud and the plate. The stud shall decrease in length during welding approximately 1/8 inch for 5/8 inch, and 3/16 inch for 3/4 inch diameter. Stud sizes indicated on drawings represent the finish stud height.
  - 2. Fillet-end welded studs: Studs may be welded using prequalified FCAW, GMAW, or SMAW processes provided the requirements of the AWS D1.1.
- K. Provide mill camber as shown on the construction documents within AISC tolerance. Place mill tolerance upward for all beams specified no camber.

# 3.3 ERECTION

- A. Structural steel erection: Comply with AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Building", latest edition.
- B. Erection Sequence: Erect steel in accordance with special erection sequences where special erection sequences are indicated on the contract documents.
- C. Before and during erection, keep all structural steel clean. Ship, handle and store steel in manner to avoid injury to members. Steel members showing evidence to rough handling or injury will be rejected.
- D. Mark each member with erection identification corresponding to mark shown on erection drawings. Carefully plan erection of structural steel so that no cutting and removal of material will be necessary. Do not torch burn in the field, unless specifically permitted by Engineer.
- E. Provide sufficient bracing, shoring and guys to effect safe and satisfactory erection. Provide bracing and shoring capable of holding steel work plumb and properly aligned while field connections are being made, and until lateral force resisting elements are deemed by Architect capable of bracing structure. Temporary bracing shall be adequate to resist lateral forces from wind or seismic prior to the completion of the lateral resisting system.
- F. Set bearing and base plates with extreme care. Bring level, to line and grade with leveling plates or by leveling nuts and bolts. Grout solid under plates with a flowable non-shrink grout per Section 03 30 00 prior to applying vertical load.
- G. Field Assembly: Set structural framing accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces which will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Shimming or other adjustments not indicated on drawings shall be approved by the Engineer prior to installation. Level and plumb individual members of the structure within specified AISC tolerances except as noted herein. Column shimming shall be 1/4 inch.
- H. All welds shall be full and clean, and conform to AISC and AWS specifications.
- I. Erection Tolerances: Individual pieces shall be erected so that the deviation from plumb, level, and alignment shall not exceed 1 to 500 plus:
  - 1. The maximum displacement of the center line of columns adjacent to elevator shafts, from the established column line, shall not be more than 1 inch at any point.
  - 2. In order to provide a true, flat plane for the exterior elevations, install all steel framing at the exterior walls of the building, so that the center lines of such framing does not vary by more than 1 inch for the length of the building. Also install each vertical member on such grids so that its vertical center line does not vary by more than 1/2 inch from a vertical line for each story and 1 inch for its full height.
  - All columns and beams shall adhere to Section M2.7 of the referenced "Specification for Structural Steel for Buildings" which states that completed members shall be free of twists, bends, and open joints. Take special care that

column base plates are parallel and perpendicular to faces of columns and that bolt holes are accurately placed.

- J. Temporary Flooring:
  - 1. Provide planking and scaffolding necessary in connection with erection of structural steel, support of erection machinery, and construction materials. Temporary floors and use of steel shall be as required by applicable regulatory requirements.
  - 2. If steel decking is used as a working platform, it shall be temporarily tack-welded to supports to extent necessary for such use in accordance with applicable regulatory requirements. The concentrated loading from welding machines and other heavy machinery required for steel erection shall be distributed by planking or other approved means. Metal decking that becomes damaged as the result of being used as a working platform shall be replaced at no additional cost to the Owner.
- K. Tower Crane: The design for the support and bracing for a tower crane shall be the responsibility of the Contractor. The design shall be prepared by a Structural Engineer licensed in the state of California. Drawings and calculations shall be stamped and signed by the structural engineer. Concentric, torsional, and/or eccentric loading to the main structure shall be resolved by the addition of structural steel for shear tabs, stiffeners, drag ties, bracing struts, etc., such items shall be designed, detailed, furnished and installed by the contractor.

#### 3.4 PAINTING AND CLEANING

- A. Prior to prime coat application, clean all loose rust, mill scale, oil, dirt, and all other materials from all steel to be left exposed. Use hand tool, power tool, sandblasting, chemical cleaning, and any other method necessary to provide a smooth, sound surface for painting.
- B. Shop prime all steel except the following:
  - 1. Steel encased in concrete
  - 2. Contact surfaces for slip-critical (sc) high strength bolts
  - 3. Areas within 4 inches of field welds
  - 4. Tops of members to receive metal decking
  - 5. Steel to be fireproofed
  - 6. Surfaces to be galvanized
- C. Use the following Type A shop painting systems on all normal environment interior steelwork:
  - 1. Surface Preparation: SSPC-SP2 Hand Tool Cleaning or SSPC-SP3 Power Tool Cleaning. Where jobsite exposure is expected to exceed 6 months, SSPC-SP6 Commercial Blast Cleaning is required.
  - 2. Application: Follow coating manufacturer's printed directions.
  - 3. Material: Type A Tnemec Company, Inc., Series V10; Sherwin Williams Steel Spec Universal; Metal Case 94-231 Series or approved equal

- 4. Number of Coats: One
- 5. Dry Film Thickness: 2.0 mils minimum.
- 6. Volume Solids: 56.0 +/- 2.0% minimum
- 7. Generic Description: Modified Alkyd.
- D. Unless noted otherwise in subsection H, use the following Type B shop painting systems on all exterior steelwork and interior steelwork subjected to wet conditions or fumes (see subsection H for additional requirements)
  - 1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning
  - 2. Application: Follow coating manufacturer's printed directions.
  - 3. Material: Type B Tnemec 90-97 Tneme-Zinc primer or approved equal
  - 4. Number of Coats: One
  - 5. Dry Film Thickness: 2.5 to 3.5 mils
  - 6. Volume Solids: 63% +/- 2%
  - 7. Generic Description: Zinc-Rich Urethane
- E. Unless noted otherwise in subsection H, use the following finish painting systems on all exterior steelwork and interior steel work subjected to wet conditions or fumes (see subsection H for additional requirements):
  - 1. Application: Follow coating manufacturer's printed directions. Apply over Type B primer system above.
  - 2. Material: Tnemec Series 750 UVX paint or approved equal
  - 3. Number of Coats: One
  - 4. Dry Film Thickness: 2.5 to 5 mils
  - 5. Volume Solids: 72% +/- 2%
  - 6. Generic Description: Polyfunctional Hybrid Polyurethane
- F. Primers and paints shall meet all federal and state environmental and air quality requirements.
- G. Apply two shop prime coats to areas which will be inaccessible after erection.
- H. All exterior steelwork and all interior steelwork subjected to wet conditions or fumes, including all welds, bolts, washers and other connection components, shall be primed and painted or hot-dip galvanized, as specified by the Architectural finish specifications. In the absence of Architectural finish specifications, all exterior steelwork and all interior steelwork subjected to wet conditions and fumes, including all welds, bolts, washers and other connection components, shall be hot-dip galvanized, conforming to the requirements set forth in ASTM A123/A123M and ASTM A153/A153M.
- I. Clean contact surfaces of high strength bolts of all burrs and material which might prevent solid seating of the parts. Steel to receive bolts shall be primer painted except beneath the contact area of slip-critical bolts.

J. After erection, field touch up all welded areas, high strength bolts, and damaged areas. For all steel to remain exposed, remove all blemishes, paint drips, and touch up prime coat.

### 3.5 HOISTING AND BRACING

- A. Provide all hoisting and erecting equipment and power.
- B. Provide and maintain any and all safety railings, toe boards, etc., required for the erection of steel framing and metal decking.
- C. Brace the erected frame in a manner which will assure safety and proper alignment to receive the metal decking and until the concrete slabs have been poured and have set.
- D. Erect building frame true and level. Erect columns in a manner to allow for movement due to welding shrinkage and thermal expansion and contraction of framing. Check plumbness after erection of each level. Maintain structural stability of frame during erection. Provide temporary bracing where necessary to maintain frame stability and to support required loads, including equipment and its operation.

### SECTION 05 12 24

# WELDING OF MOMENT FRAMES

### PART 1 - GENERAL

- 1.1 GENERAL REQUIREMENTS
  - A. Requirements of Division 1 apply to all Work of this Section.

# 1.2 SCOPE

- A. Furnish materials and perform all labor necessary for the welding of Moment Resisting Frames. This includes both field and shop welding for the complete moment resisting joint.
- B. Welding:
  - All Welding shall be performed in full accordance with the latest edition of the AWS D1.1 Structural Welding Code-Steel, except as supplemented or modified by this specification. Reiteration or amplification of code provisions as contained in the specification shall not reduce the necessity of compliance with all other code requirements. All aspects of design, workmanship, technique, qualifications of welders, welding procedure specifications, and inspection shall comply with code requirements. The provisions of Clause 2 Part B, Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded), shall apply.
  - 2. Comply with provisions of AWS D1.8 and AISC 341 Chapter J.
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 05 12 00 Structural Steel

#### 1.4 QUALITY ASSURANCE

- A. Welder Qualification:
  - 1. All welders, welding operators, and tack welders shall be qualified by test and hold a current valid certificate issued by an independent testing agency, to perform the type of welds required by the work; including the process, position, and thickness of materials used (D1.1: Section 4).
  - 2. In addition to meeting the requirements above, welders shall have experience and/or training to enable them to successfully make the welds required in the special moment resisting frames. Additional training for welders that are otherwise "qualified" may be necessary. Each contractor shall be responsible to ensure that all welders employed on the project have proper training and qualification testing consistent with the requirements of AWS D1.8 Section 5
  - 3. All welders on the project shall be capable of understanding and following the requirements of the written WPS.
  - 4. Each welder employed on the project shall understand all the requirements of this welding specification before welding on the project.
- B. Standards and References: (Latest Edition unless specified otherwise)
  - 1. Reference Data:

- a. If the year of the adoption or latest revision is omitted from the designation, it shall mean the specification, manual or test designation in effect the date the Notice to Proceed with the Work is given.
- 2. American Welding Society
  - a. Structural Welding Code Steel (AWS D1.1)
  - b. Structural Welding Code Seismic Supplement (AWS D1.8)
- 3. American Institute of Steel Construction
  - a. Specification for Structural Steel for Buildings (AISC 360)
  - b. Code of Standard Practice for Steel Buildings and Bridges (AISC 303)
  - c. Seismic Provisions For Structural Steel Buildings (AISC 341)
  - d. Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications (AISC 358)
- 4. California Building Code (CBC)
- C. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Fabricator and Erector Documents
    - a. Submit all documents required by AISC 360 Section N3.1 and AISC 341 Section J.2
  - 2. Quality Assurance (Testing) Agency Documents
    - a. Submit all documents required by AISC 341 Section J3.
- D. Tests and Inspections:
  - 1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
  - 2. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC, AISC 360 and 341 requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 3. Inspections
    - a. Owner shall engage an independent testing and inspection agency. See Section 01 45 00
    - b. Qualifications: All Inspectors shall meet the requirements of AWS D1.1, paragraph 6.1.4, AWS D1.8 Section 7.2, AISC 360 Section N4, and AISC 341 Section J4.
    - Inspection Agency Responsibility: The inspection agency shall perform all code required inspection including AWS D1.1 Section 6, AWS D1.8 Section 7, AISC 360 Section N5, AISC 341 Sections J5 through J9, and the requirements specified herein.

- d. In-Process Inspection: The Inspector is responsible for in-process inspection which includes the following:
  - 1) Inspect materials and equipment (D1.1: 6.2)
  - 2) Review WPS's (D1.1: 6.3)
  - 3) Review welder qualifications (D1.1: 6.4)
  - 4) Observe the joint preparation, assembly practice, welding technique, and performance of each welder (D1.1: 6.5.2)
  - 5) Inspect the final weld to ensure that it is of the proper size, length, and location (D1.1: 6.5.1)
  - 6) Confirm that the specific welding parameters employed are within the applicable limits of the written WPS (D1.1: 6.3.3)
  - 7) Inspect the weld to ensure it is crack free (D1.1: table 6.1)
  - 8) Inspect the weld to ensure that thorough fusion exists between layers of weld metal and between the weld metal and base metal (D1.1: Table 6.1)
  - 9) Ensure that all craters are filled to the complete cross-section of the weld (D1.1: Table 6.1)
  - 10) Ensure that the weld profiles meet the geometric requirements (D1.1: 5.24)
  - 11) Inspect the weld to ensure length meets the minimum requirements and any required corrections are made (D1.1: Table 6.1)
  - 12) Inspect weld to ensure that any undercut does not exceed the limits of D1.1, Table 6.1
  - 13) Inspect the weld to ensure that any porosity does not exceed the limits of D1.1 Table 6.1
  - 14) The Inspector shall also ensure that all the requirements of this specification are met (D1.1: 6.1.4)
- 3. Testing
  - One hundred percent of complete joint penetration (CJP) groove welds shall be subject to ultrasonic testing (UT), and twenty five percent of complete joint penetration (CJP) beam-to-column groove welds shall be subject to magnetic particle testing (MT) per AWS D1.1, Section 6.10, 6.13 and AISC 341 Chapter J. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.
  - b. The amount of MT testing on CJP groove welds is permitted to be reduced if the requirements of AISC 341 Chapter J, Section J6.2h are satisfied.
  - c. Column Flanges: An area extending 6" above and below point where girder flanges are attached shall be inspected. Column flange edges shall be inspected visually, and entire area ultrasonically for lamination, plate discontinuities, and non-metallic inclusions.
  - d. Ultrasonic inspections of CJP welds shall be conducted from both the top and bottom sides of the beam flange, and from the back side of the column flange as necessary to determine potential rejectable welding defects.
  - e. All weld tabs shall be removed. The affected area shall be ground smooth and magnetic particle tested for defects. (Dye penetrant may used where required).
  - f. Where back-up bars are required to be removed, the weld root area shall be magnetic particle tested for defects.
  - g. Base metal thicker than 1-1/2" loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than <sup>3</sup>/<sub>4</sub>"

and contains CJP groove welds, shall be ultrasonically tested for discontinuities behind and adjacent to the fusion line of such welds per AISC 341 Chapter J, Section J6.2c.

#### PART 2 – PRODUCTS

- 2.1 MANUFACTURERS
  - A. Acceptable Manufacturers:
    - 1. Manufacturers of materials are listed to set a standard for design and product performances.
    - 2. Subject to the requirements of DIVISION 1, products of manufacturers not listed may be proposed for substitution, provided that they are equal in design, product performance and warranty to the products specified.
    - 3. The burden of proof of equality of proposed products is on the Contractor.

#### 2.2 MATERIALS

- A. Electrodes:
  - 1. All electrodes used in moment frame connections shall provide a minimum charpy Vnotch (CVN) toughness of 20 ft-lbs at -20 ° F and 40 ft-lbs at 70 ° F in accordance with the appropriate AWS classification and AISC 341.
  - 2. For all self-shielded flux core arc welding (FCAW), use E70T7-K2, E70T-6, or E71T-8 electrodes for all flat and horizontal position welds. For welds other than flat or horizontal position, use E71T-8 electrodes. This shall include reinforcing fillet welds placed at the root of groove welds after back up bar removal and fillet welds connecting the shear tabs to the beam webs.
  - 3. For all shielded metal arc welding (SMAW), use E7018 electrodes for all welds.
  - 4. For flat and horizontal welds use 7/64" diameter electrodes maximum. For other welds use 5/64" diameter electrodes maximum.
  - 5. Electrodes, unless noted otherwise herein, shall be AWS A5.1 E70XX electrode minimum.
  - 6. For electrodes used for Demand Critical Welds, provide WPS Heat Envelope high and low values, either from manufacturer literature or other additional testing per AWS D1.8, Annex A.
- B. Plates: ASTM A572 Grade 50 typical, ASTM A-36 where specified.

#### 2.3 WELDING PROCESSES

A. Prequalified Welding Processes

At the contractor's option, SMAW, FCAW (gas-shielded and self shielded), GMAW (except short-circuited transfer), and SAW may be used with prequalified welding procedure specifications (See 3.1). (D1.1: 3.2.1)

B. Other Welding Processes

ESW, EGW and GTAW may be used at the contractor's option, providing the welding procedure specifications are qualified by test. Other processes may be employed, subject

# PART 3 – EXECUTION

#### 3.1 WELDING PROCEDURE SPECIFICATION (WPS)

- A. All welding shall be performed in strict adherence to a written WPS, whether or not the WPS is prequalified or qualified by test.
- B. All WPS's shall be prepared by qualified individuals and the same individual responsible for the suitability of the WPS shall be recorded on the WPS.
- C. The written WPS shall be available to the welder, welding supervisor, and inspector.
- D. The welding machinery shall be equipped with suitable meters which are in proper working conditions to enable the welder to control the essential welding parameters listed in the WPS. (D1.1: 5.11) If the equipment is not so equipped, or if the instrumentation is not functioning, external measuring devices shall be used, provided they are available to all individuals as required for maintenance welding parameters.
- E. WPS's may be prequalified providing they meet all the requirements of AWS D1.1 Clause
  3. Any deviation from the prequalified WPS requirements shall necessitate qualifications by test. (D1.1: 3.1)
- F. WPS's that are not prequalified shall be subject to the qualification testing specified in D1.1, Clause 4. For WPS's that have been qualified by test, the supporting procedure qualification record (PQR) shall be available to the welding supervisor and inspector upon their request. (D1.1: 4.7)
- G. The written WPS shall contain all the necessary information required by the code, this specification, and any other information necessary to produce welds that are in compliance with these requirements.
  - 1. The WPS shall list the applicable base metal types and thicknesses.
  - 2. The WPS shall contain a sketch of the joint and shall list the welding joint details, including type, weld type, joint geometry, and applicable dimensions. Individual weld passes shall be identified in the sketch and numbered to identify the maximum layer thickness and bead widths. In no case shall the layer thickness exceed 1/4", nor shall the maximum bead width exceed 5/8".
  - 3. The WPS shall list the applicable welding processes.
  - 4. The WPS shall list the filler metal specification and AWS classification, as well as details regarding shielding material used.
  - 5. The WPS shall indicate the minimum preheat requirements. The minimum specified preheat shall meet the requirements of D1.1, Table 3.2.
  - 6. The WPS shall list all applicable electrical characteristics for the process employed. The WPS shall clearly indicate the acceptable values required for each welding pass. These electrical characteristics shall include at a minimum the following:
    - a. Type of current, and acceptable ranges of current measured in amperage. For wire feed processes, at the contractor's option, wire feed speed may be listed in lieu of current.

- b. Voltage (for wire feed processes)
- c. Travel speed (range)
- d. Electrode extension for wire feed processes
- e. Amperage, voltage and electrode extension (as applicable) shall be within the filler metal manufacturer's recommendation.
- f. High and Low heat input range for the specified range of welding parameters. Provide comparison to the qualified heat input range for the specific electrode to be used.
- 7. The diameter of the electrodes specified on the WPS shall not exceed that indicated in this specification.
- 8. The WPS shall indicate that each pass shall be completed in its entirety before subsequent passes are deposited.

# 3.2 FABRICATION

- A. Weld Access Holes: Weld access holes shall be adequately sized to ensure adequate access for welding and inspection (D1.1: 5.17). A minimum length from the toe of the weld preparation to the end of the hole is made. The height of the access hole shall be a minimum of the thickness of the material in which the hole is made, but in no case shall be less than 3/4". Shear tabs shall be sized to ensure the weld access hole region remains unobstructed. The radii of weld access holes shall be in compliance with the requirements indicated on the drawings and AWS D1.8 Subclause 6.10.1.2.
- B. Assembly:
  - Assembly tolerances shall not exceed those for the prequalified joint detail employed, or the limits of D1.1: 5.22, as applicable. The minimum root opening dimension shall be maintained for the length of the joint. For joints where the minimum root opening dimension is less than the minimum requirement, compensation may be made by increasing the root opening by gouging, chipping, or grinding. At the contractor's option, an alternate approved written WPS suitable for the smaller root opening may be employed. Root openings that exceed the maximum allowable may be corrected by welding to acceptable dimensions prior to joining the parts by welding. The Architect and Structural Engineer shall be notified when the root opening exceeds the allowable tolerance range.
  - 2. Bolts shall be fully torqued only after welds have been completed for both flanges. The fillet weld from beam web to shear tab shall be made after the bolts are fully torqued.
- C. Tack Welds:
  - 1. All tack welds shall be of the same quality as the final welds and shall be made with a qualified or prequalified WPS and by qualified personnel (D1.1: 5.18.1). This includes the requirements for preheat, unless the final weld is made by a submerged arc weld that remelts the single pass tack weld. (D1.1: 5.18.5).
- D. Peening:
  - 1. At the contractor's option, peening may be used on intermediate layers for control of shrinkage stresses to prevent cracking or distortion or both. No peening shall be done on the root pass or surface layers (D1.1: 5.27).

- E. Weld Cleaning:
  - 1. Before welding over previously deposited metal, all slag shall be removed from the weld and the adjacent base metal shall be brushed clean. The final weld layers shall be cleaned by brushing or other suitable means (D1.1: 5.30).
- F. Sequencing of Bottom Flange to Column Weld:
  - 1. Complete joint penetration (CJP) groove welds of beam bottom flanges to column flanges, or to continuity plates, using weld access holes shall be sequenced as follows (AWS D1.8, 6.14):
    - a. Weld starts and stops shall not be made directly under the beam web.
    - b. Each layer shall be completed across the full width of the flange before beginning the next layer.
    - c. For each layer, the weld starts and stops shall be on the opposite side of the beam web, as compared to the previous layer.
- G. Steel Backing:
  - 1. Groove welds made with the use of steel backing shall have the weld metal thoroughly fused with the backing (D1.1: 5.10.1)
  - 2. Steel backing shall be made continuous for the full length of the joint, and shall continue into the area of weld tabs. (D1.1: 5.10.2)
  - 3. Steel backing at beam flange to column flange joints shall not be welded to the underside of the beam flange. Tack welds are not permitted in this area (D1.8: 6.9.2).
  - 4. Steel backing on the bottom flange connection of special moment resisting frames shall be removed and proper treatment shall be given to the weld root (D1.8: 6.7). Unless detailed otherwise on the drawings, reinforcing fillet with a leg size of 5/16" minimum shall be applied (D1.8: 6.8). Where column flanges are being welded (i.e. column splices), both flanges shall receive this treatment.
- H. Weld Tabs:
  - 1. Weld tabs shall be employed to enable welds to be terminated at the end of the joint in a manner that will ensure sound welds (D1.1: 5.31.1). Weld tabs shall extend a minimum of 1" or thickness of the part, whichever is greater, beyond the edge of the joint. Weld tab length need not exceed 2" (D1.8: 6.11.1). The weld tabs shall substantially duplicate the groove weld profile.
  - 2. "End dams" that result in the application of auxiliary metal that is perpendicular to the longitudinal length of the weld shall not be used.
  - 3. Weld tabs shall be removed upon completion and cooling of the weld unless noted otherwise on the drawings, and the ends of the weld shall be made smooth and flush with the edges of abutting parts. (D1.1: 5.31.3). Removal requirements shall be in compliance with AWS D1.8, subclause 6.11.3.

# SECTION 05 30 00

### METAL DECKING

# PART 1 – GENERAL

# 1.1 GENERAL REQUIREMENTS

A. The requirements of Division 01 apply to all Work of this Section.

# 1.2 SCOPE

- A. Provide all steel decking, accessories and cutting and reinforcing of all holes as indicated on Drawings and specified here.
- 1.3 RELATED WORK (See also Table of Contents):
  - A. Section 01 84 15 Supporting from Structure
  - B. Section 03 30 00 Cast-In-Place Concrete
  - C. Section 05 12 00 Structural Steel
  - D. Section 05 50 00 Metal Fabrications
  - E. Holes for Mechanical and Electrical Work: Divisions 21, 22, and 26.
    - 1. Cutting and reinforcing of holes for plumbing and electrical conduits shall be part of this work providing holes are located by the mechanical and electrical contractors prior to or during installation. Cutting and reinforcing of holes after installation shall be the responsibility of those trades requiring them.
    - 2. Miscellaneous connection requirements for Mechanical and Electrical Work: Divisions 21, 22 and 26.

#### 1.4 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
  - 1. California Building Code (CBC)
  - 2. American Iron and Steel Institute (AISI). "Specification for the Design of Cold-Formed Steel Structural Members."
  - 3. American Welding Society (AWS): AWS D-1.3 "Structural Welding Code Sheet Steel"
- B. Submittals: (Submit under Provisions of Section 01 33 23)
  - 1. Shop Drawings. Submittal required. Indicate deck sheet layout and all installation details. Contract documents may not be used as shop drawings.
  - 2. Manufacturer's specifications for each Deck Type. Submittal required.
  - 3. Certification: Provide affidavits from the manufacturer listing mill test certificates by number for each size and type of decking.
  - 4. Manufacturer shall provide affidavits of approval by the International Code Council Evaluation Service (ICC-ES) for the metal decking shapes proposed.

- 5. Floor areas to receive concrete fill over metal deck: Provide a work plan detailing the means and methods to be used for placement of concrete, including screeding procedures and locations of any construction joints, which will achieve the performance criteria noted in Section 2.1. A pre-construction meeting shall be scheduled by the General Contractor, to include the concrete sub-contractor, Architect, Structural Engineer, and Owner's Representative to discuss the work plan and performance objectives.
- C. Tests and Inspections:
  - 1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
  - 2. A testing program is required prior to start of construction. Testing program to be done In Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 3. All materials, methods and equipment shall be subject to inspections by the Testing Laboratory at any time.
  - 4. Material Testing: Test reports establishing conformity to the specifications shall be furnished to the Owner for each heat prior to installation.
  - 5. Welding Inspection: Welding of metal deck shall be performed under the inspection of the Testing Laboratory. Inspection shall be in accordance with SDI QA/QC.
  - 6. Powder Actuated Fasteners (shotpins): Where decking is attached with shotpins, the pins shall be inspected for proper installation by a special inspector. Twenty-five percent (25%) of all pins shall be verified using the inspection tool supplied by Hilti Inc.

# 1.5 PRODUCT HANDLING

A. Protect metal decking before installation and protect the installed work and materials of other trades.

# PART 2 – PRODUCTS

# 2.1 GENERAL REQUIREMENTS - DECK SYSTEMS

- A. Acceptable Manufacturers:
  - 1. ASC Steel Deck
  - 2. Verco Manufacturing Co.
  - 3. Manufacturers of materials are indicated to set a standard for design and product performances.
  - 4. Subject to the requirements of Division 01, products of manufacturers not indicated may be proposed for substitution, provided that they are equal in design, product performance and warranty to the products specified and have ICC approval.

- 5. The burden of proof of equality of proposed products is on the Contractor.
- B. Provide deck sections, type and gage as indicated on the drawings. Other manufacturers producing deck complying with these Specifications, and having equivalent properties and dimensions will be subject to the Architect's review upon submission of substantiating data, and may be used only if equivalent to deck sections specified, in the Architect's opinion.
- C. All deck units shall be approved by International Code Council Evaluation Service (ICC-ES) for use as a diaphragm.
  - 1. Diaphragm shear capacities shall be comparable (within 5%) to those listed on the drawings for the deck, welding, and spans indicated.
- D. Units shall be in lengths to span two or more supports. Where steel layout does not permit two-span minimums, notify the Structural Engineer prior to fabrication.
- E. For limitations of loads to metal decking see Section 01 84 15.
- F. All deck units shall have male and female interlocking side joints.
- G. All deck units with concrete or insulating concrete shall be vented to provide 1% open area.
- Prior to covering or filling with insulation, roofing, or placing concrete over metal decking, verify and coordinate installation requirements of suspended metal framing, suspended acoustical ceiling systems, mechanical and electrical work or other items as required. Provide inserts, clips, anchors or fasteners as indicated or as otherwise required to provide for the complete and proper installation of suspended items from the metal deck.
  - 1. Verify and coordinate locations, patterns, spacing, etc. of suspension members and connectors required by other Sections of the Specifications and as shown on drawings.
  - 2. Where suspension or hanger wires are required under other Sections, verify and coordinate locations, patterns, spacings, etc. with the appropriate trade. Drill holes at bottom of deck flutes of sufficient size to pass support wires. Wire supports shall be looped and secured with a minimum of three (3) tight turns around a minimum 1-1/2" x 8" long furring channel or No. 3 x 12" long reinforcing bar centered above the hole and laid in the deck flutes. Pig-tail loops into the concrete will not be permitted unless approved by the General Contractor. Place no wires in flute with side lap.
  - 3. At unfilled metal deck or as otherwise indicated, required or shown, provide individual 18 gauge by 1-1/2" wide galvanized hanger tabs 6" long and having 2" round holes for attaching tie wires. Tabs shall be hooked over male portion of each edge joint at 16" on center before female joint of next sheet is placed over it. As an alternate, #3x12" long reinforcing bars centered above the hole and laid in the deck flutes may be used. No loading other than suspended ceilings may be suspended from metal deck without concrete fill. Suspend all piping, ducting, conduit and equipment from steel beams.
- I. Structural Properties: Deck shall have minimum structural properties as indicated on Structural Drawings.
- J. Accessories to be furnished shall include the following:
  - 1. Cell closures where shown on Drawings.

- 2. Light gauge plate fillers attached to deck to provide an uninterrupted roof plane.
- 3. Drain sumps and/or roof drain mounting plates as detailed.
- 4. Cell end closures column flashing and miscellaneous closures to prevent concrete leakage.
- 5. Miscellaneous accessories incidental to erection of deck.
- K. At concrete filled metal deck floors:
- 1. The final top of concrete elevation shall not deviate by more than 3/8" above or below the top of concrete elevation noted on plan.
- Floor flatness for concrete over metal deck shall conform to ACI 117. Unless stricter requirements are specified by the Architect, floor flatness for the completed overall floor area shall meet the following minimum values: Specified Overall Value for Flatness (SOF<sub>F</sub>): 25 Minimum Local Value for Flatness (MLF<sub>F</sub>): 17 Areas of non-compliance shall be reviewed by the Owner and Architect and may require additional floor leveling or grinding. The cost of any remedial action shall be borne by the Contractor.
- 3. In no case shall the depth of concrete over metal deck be less than that specified on plan. Note that the concrete depth will vary due to deck and beam deflections during concrete placement, and shall be considered in the estimating of concrete volume, cost and placement strategies.
- L. At concrete filled metal deck roofs:
  - 1. Concrete over metal deck at roofs shall be placed to maintain the design thickness specified on plan at all locations within the roof area. Additional concrete (ponding) which increases the thickness above the design thickness to achieve flatness, levelness or maintain roof slope should not be provided.

#### 2.2 MATERIALS

- Provide deck of type and gage shown on the drawings. Deck units and all necessary items shall be formed from steel sheets conforming to ASTM-A653, structural quality. The steel sheets shall have received, before being formed, a metal protective coating of zinc conforming to ASTM-A653 Class G60 coating.
- B. Powder Actuated Fasteners (shotpins): Where decking is attached with shotpins, they shall be by Hilti Inc., of the type indicated on the drawings and ICC-ES approved for use in a diaphragm.
- C. Welding rods: E60XX minimum.

# PART 3 - EXECUTION

# 3.1 INSPECTION

- A. Examine areas to receive work specified. Do not begin work until underlying work is complete, all required inspections have been made, and all conditions which might prevent proper installation or impair performance of work have been corrected.
- B. Beginning installation means accepting conditions of underlying work.

C. If supporting steel work is not properly aligned or sufficiently level to permit proper bearing of metal decking, such deficiency shall be corrected by the Contractor before placing units.

# 3.2 ERECTION

- A. Deck shall be laid true to line, shall conform to profile shown on Drawings, and shall be without deformations, creases, wrinkles or noticeable defects.
- B. Connections: Deck shall be secured to structural frame by use of 15/16" visible diameter (1/2" effective diameter) fusion welds. Minimum number and spacing of connections shall be as indicated on Structural Drawings.
- C. The metal deck shall be fastened to all structural members both parallel and perpendicular. Spread deck and modify layout where structural members are parallel to the metal deck ribs.
- D. Bend decking to conform to slopes and warps as required for solid contact to framing that allows proper welding.
- E. Shoring for metal decking shall be provided by the contractor as required and as indicated in the corresponding ICC-ES report. Coordinate shoring requirements for construction live load (and concrete placement) with the manufacturer.
- F. All deck units shall break over beams.
- G. Provide low ribs at all beams parallel to deck. As an alternate, the deck may be broken and infilled with a flat pan to provide deck welding to parallel beams.
- H. Butt deck units tight over steel beams.
- I. Provide 3/4" clear concrete cover around all welded studs.

#### 3.3 DEFECTIVE DECK

A. Units of decking that become deformed or damaged to such extent that they are weakened or unsuitable for use shall be removed and replaced at no cost to the Owner.

#### 3.4 TOUCH UP AND CLEANING

- A. All welds and abrasions on deck surfaces not covered by concrete shall be touched up using a zinc dust-zinc oxide primer.
- B. Burn spots on supporting exposed steel shall be touched up with same primer as used on adjacent surface.
- C. Clean surfaces of installed deck by effective means to receive sprayed-on fireproofing or finish painting as indicated.

# SECTION 05 40 00

#### COLD-FORMED METAL FRAMING

### PART 1 – GENERAL

### 1.1 GENERAL REQUIREMENTS

- A. The requirements of Division 01 apply to all Work in the Section.
- 1.2 SCOPE
  - A. Furnish and install all components and related items pertaining to cold-formed metal framing systems.
- 1.3 RELATED WORK SPECIFIED ELSEWHERE (See also Table of Contents)
  - A. Section 03 30 00 Cast-in-place concrete
  - B. Section 05 05 19 Post-Installed Concrete Anchors
  - C. Section 05 12 00 Structural Steel
  - D. Section 05 30 00 Metal Deck
  - E. Section 06 10 00 Rough Carpentry
  - F. Section 06 16 43 Gypsum Sheathing
  - G. Section 07 22 00 Roof & Deck Insulation
  - H. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

#### 1.4 QUALITY ASSURANCE

- A. General:
  - 1. Welders: Qualified for welding in horizontal, vertical, and overhead positions in accordance with AWS D1.3.
  - 2. Wall system shall provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperatures.
  - 3. Wall system shall accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- B. Standards and References: (Latest Edition unless noted otherwise)
  - 1. California Building Code (CBC)
  - 2. ASTM A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - 3. Framing components shall conform to Standards of the Steel Stud Manufacturers Association (ICC-ES ER-3064P)
- C. Submittals: (Submit under provisions of Section 01 33 23)

- 1. Manufacturers catalog with sizes to be used indicated
- 2. ICC-ES report
- 3. Mill certificates verifying steel properties

# 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal framing units from rusting and damage.
- B. Deliver to Project site in manufacturer's unopened containers or bundles, identified with name, brand, type and grade.
- C. Store off ground in a dry ventilated space or protect with suitable waterproof covering.

# PART 2 – PRODUCTS

- 2.1 ACCEPTED MANUFACTURERS
  - A. Members of the Steel Stud Manufacturer's Association (SSMA), or approved equal.

# 2.2 METAL FRAMING

- A. System Components: Provide steel studs, joists, tracks, straps, runners, blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as shown on the Drawings for applications indicated. All studs, joists, tracks, and blocking shall conform to ICC-ES ER-3064P.
- B. Materials and Finishes:
  - 1. 54 Mils (16 Gauge) and Thicker: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 50,000-psi, conforming to ASTM A653, SS Grade 50 Class 1 or ASTM A1003, Grade 50 Type H (ST50H).
  - 2. 43 Mils (18 Gauge) and Thinner: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 33,000-psi, conforming to ASTM A653, SS Grade 33 or ASTM A1003, Grade 33 Type H (ST33H).
  - 3. Finish: Galvanized complying with ASTM A653, G90. Finish accessories to match main framing components.
- C. See drawings for section properties and details.
- D. Studs and joists shall be of the size, shape, and gauge indicated, with a flange and flange return lip as shown on the Structural Drawings.
- E. Welding Electrodes: E60XX (43 Mil material and thinner), E70XX (54 Mil material and thicker)
- F. Galvanizing Repair Paint: High zinc-dust content paint for repair of galvanized surfaces damaged by welding.
- G. Material Thickness: All sections are to be roll formed in various depths with the following minimum bare metal thicknesses:

Minimum Thickness (inch)	Minimum Design Thickness (inch)	Gauge	Mils
0.0179	0.0188	25	18
0.0329	0.0346	20	33
0.0428	0.0451	18	43
0.0538	0.0566	16	54
0.0677	0.0713	14	68
0.0966	0.1017	12	97
0.1180	0.1240	10	118

# PART 3 – EXECUTION

# 3.1 INSTALLATION

- A. Install metal framing systems in accordance with the Structural Drawings. Where drawings conflict with manufacturer's recommendations, the Structural Drawings will govern.
- B. Runner Tracks:
  - 1. Install continuous tracks sized to match studs. See Structural Drawings.
  - 2. Align at base and tops of studs.
  - 3. Attach tracks with screws, welding, bolting or shot pins as indicated on the Structural Drawings.
  - 4. Fasten corners and ends of tracks as shown.
- C. Studs:
  - 1. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces.
  - 2. Where studs abut structural columns or walls, anchor ends of stiffeners to supporting structure.
  - 3. Secure studs to top and bottom runner tracks by screw fastening at both flanges.
  - 4. Install studs in one piece for full height; splicing of studs is not permitted.
  - 5. Provide deflection allowance of 1/2" minimum in stud track, directly below horizontal building framing for all non-bearing wall framing. See Structural Drawings.
  - 6. Install ends of studs tight to web of track at all bearing wall framing. Compress track against end of stud as required to achieve tight fit prior to installation of stud to track screw attachments. See Structural Drawings.
  - 7. Install supplementary backing and bracing wherever walls or partitions are indicated to support equipment, services, casework, heavy trim and furnishings and similar work requiring attachment to wall or partition. Comply with stud manufacturer's instructions and industry standards.
  - 8. See Structural Drawings for opening framing.

- 9. Frame both sides of expansion and control joints, with separate studs; do not bridge the joint with components of stud system.
- 10. Install one row of metal blocking or bridging at mid-height of all studs over 10'-0" in height in addition to bracing that may be required at studs that do not receive sheathing (see item 11 below).
- 11. Install strapping to all sides of studs that do not receive sheathing as indicated on the structural drawings.

# 3.2 TOUCH-UP PAINTING

- A. Touch-up shop-applied protective coatings damaged during handling and installation.
- B. Use compatible primer for prime coated surfaces; use galvanizing repair paint for galvanized surfaces.
# SECTION 05 43 00

# SLOTTED CHANNEL FRAMING

# PART 1 – GENERAL

- 1.1 SUMMARY
  - A. Framing shall be a strut type metal framing system (Strut System)
  - B. Strut System shall be used:
    - 1. To support mechanical and electrical equipment, piping/conduit, and devices.
    - 2. For structural applications as applicable.
  - C. The Strut System and all components must be supplied from a single approved Manufacturer.

# 1.2 REFERENCES

- A. ASTM A123 Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
- B. ASTM A653 General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process
- C. ASTM A1011 Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formablility (Formerly ASTM A570)
- D. ASTM F1136 Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners
- E. ASTM A907 Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled, Structural Quality
- F. ASTM B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- G. MFMA Metal Framing Manufacturers Association
- H. ANSI/NFPA 70– National Fire Protection Association (National Electrical Code)
- I. AISI American Iron and Steel Institute

# 1.3 QUALITY ASSURANCE

- A. Manufacturer's qualifications:
  - 1. The manufacturer shall have at least 10 years' experience in manufacturing Strut Systems.
  - 2. The manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.

- B. Work shall meet the requirements of the following standards:
  - 1. Federal, State and Local codes
  - 2. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members 2001 Edition
  - 3. American Society for Testing And Materials (ASTM)
  - 4. Metal Framing Manufacturer's Association (MFMA)
- C. UL Compliance: Comply with UL "Standard for Surface Metal Raceway and Fittings", UL 5.
- D. Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

# 1.4 SUBMITTALS

- A. Structural calculations by a Registered Professional or Structural Engineer in the State of the Project's location for approval by the Professional of Record. Calculations may include, but are not limited to:
  - 1. Description of design criteria
  - 2. Stress and deflection analysis
  - 3. Selection of framing members, fittings, and accessories
- B. Assembly drawings necessary to install the Strut System in compliance with the Contract Drawings
- C. Submit manufacturer's product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns. For each different strut cross-section, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

# 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver strut systems and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

#### 1.6 WARRANTY

A. Manufacturer shall warrant for 1 year from the shipment date that products will be free from defects in material or manufacture. In the event of any such defect in violation of the warranty, Manufacturer shall have the option to repair or replace any such defective product.

B. Installer shall warrant for 1 year from the date of completion of work that the work will be free of defects in installation. In the event of any such defect in violation of the warranty, Installer shall have the option to repair or replace any such defective product.

# PART 2 – PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with these specifications, pipe support systems shall be:
  - 1. "Unistrut" Unistrut Service Company; 739 Moore Road, Cleveland, Ohio 44012; 1-855-923-2611; <u>www.unistrutohio.com</u>
  - 2. "B-Line" Cooper B-Line, Inc.; 509 West Monroe Street, Highland, IL 62249; (800) 851-7415; <u>www.eaton.com/us/en-us/catalog/support-systems/strut-channel.html</u>
  - 3. "G-Strut" G-STRUT; 4100 13th Street, SW Canton, Ohio 44710; 866-997-8788; www.gstrut.com
- B. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.
- 2.2 STRUT CHANNELS AND COMPONENTS
  - A. All channel members shall be fabricated from structural grade steel conforming to one of the following ASTM specifications: A 1011 SS GR 33, A 653 GR 33. All Fittings shall be fabricated from steel confirming to one of the following ASTM specifications: A 575, A 576, A 36, or A 635.
  - B. General: Strut shall be 1-5/8 inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the drawings.
  - C. Materials and Finish: Material and finish specifications for use on this project shall be:
    - Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123 or A 153. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be chromium zinc ASTM F1136 Gr. 3.

# PART 3 – EXECUTION

# 3.1 EXAMINATION

A. The installer shall inspect the work area prior to installation. If work area conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

### 3.2 INSTALLATION

A. Installation shall be accomplished by a fully trained manufacturer authorized installer.

- B. Set Strut System components into final position true to line, level and plumb, in accordance with approved drawings.
- C. Anchor material firmly in place, and tighten all connections to their recommended torques.

# 3.3 CLEANUP

A. Upon completion of this section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

#### 3.4 PROTECTION

- A. During installation, it shall be the responsibility of the installer to protect this work from damage.
- B. Upon completion of this scope of work, it shall become the responsibility of the general contractor to protect this work from damage during the remainder of construction on the project and until substantial completion.

# END OF SECTION

# SECTION 05 50 00

# METAL FABRICATIONS

### PART 1 – GENERAL

- 1.1 GENERAL REQUIREMENTS
  - A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 specification Sections apply to Work of this Section as if printed herein.
- 1.2 SCOPE
  - A. Shop fabricated metal items and miscellaneous metal work.
  - B. Refer to Schedule at end of this Section.
- 1.3 PRODUCTS FURNISHED BY OTHERS BUT INSTALLED UNDER THIS SECTION
  - A. Section 05 43 00 Slotted Channel Framing
  - B. Section 05 53 00 Metal Grating
  - C. Section 07 72 00 Roof Accessories
- 1.4 RELATED SECTIONS
  - A. Section 07 54 16 Ketone Ethylene Ester Roofing
  - B. Section 07 56 00 Fluid Applied Roofing
  - C. Section 07 92 00 Joint Sealants
  - D. Section 08 33 23 Overhead Coiling Doors
  - E. Section 09 91 00 Painting
  - F. Section 09 97 13 Steel Coatings

#### 1.5 REFERENCES

- A. Standards and References: (Latest Edition unless otherwise noted)
  - 1. California Building Code (CBC)
  - 2. American Society for Testing and Materials (ASTM) Specifications as listed in the Section.
- B. ASTM A36 Structural Steel
- C. ASTM A53 Hot Dipped, Zinc Coated Welded and Seamless Steel Pipe
- D. ASTM A307 Low Carbon Steel Externally and Internally Threaded Fasteners

- E. ASTM A386 Zinc Coating (Hot Dip) on Assembled Steel Products
- F. ASTM A501 Hot Formed Welded and Seamless Carbon Steel Structural Tubing
- G. AWS DI.1 Structural Welding Code
- H. FS TT P 31 Paint: Iron Oxide, Ready Mix, Red and Brown
- I. FS TT P 641 Primer Coating, Zinc Dust Zinc Oxide (for Galvanized Surfaces)

#### 1.6 SHOP DRAWINGS

- A. Submit shop drawings under provisions of Section 01 33 23 Shop Drawings, Product Data, and Samples. Indicating profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
- B. Include erection drawings, elevations, and details where applicable.
- C. Contractor shall provide fully engineered construction shop drawings for all structural components. Engineered drawings shall be engineered and signed by a California Registered Civil or Structural Engineer.
- D. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.
- E. Contractor to verify all dimensions on site prior to developing shop drawings and include same in the shop drawings for the review.

#### 1.7 QUALIFICATIONS

A. Welder Certificate: Submit per Section 01 33 23 Shop Drawings, Product Data, and Samples; AWS qualification for all welders both in the fabrication shop and on the job site to perform work under this section.

#### 1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver all parts ready for erection; store in close proximity to final locations.

# PART 2 – PRODUCTS

#### 2.1 MATERIALS

- A. Steel Sections: ASTM A36
- B. Sheet Steel: ASTM A446, Grade A
- B. Steel Tubing: ASTM A500, Grade B
- C. Steel Pipe: ASTM A53, Type E or S, Grade B
- D. Steel Bolts, Nuts, and Washers: ASTM A307

- E. Welding Materials: AWS D1.1; type required for materials being welded
- F. Galvanizing: Hot-dip process ASTM A123 typical and ASTM A153 for threaded fasteners performed after fabrication into largest practical section. Weight of coating not less than 2 oz. per sq. ft. of surface. Where damaged, repair surface with one coat of hot process galvanizing repair compound, "Galvalloy", Galvweldalloy", or approved equal.
- G. Primer: Tnemec Company "Series V10 Red Primer", Sherwin-Williams "Steel Spec Universal Primer"; or approved equal.
- H. Dissimilar Materials: Separate dissimilar surfaces in contact with or in close proximity to non-compatible metals, concrete masonry, or plaster with neoprene gasket; or other approved means.
- I. Expansion Bolts: Hilti "Kwik Bolt TZ" Expansion Anchor Bolts, galvanized unless otherwise indicated.
- J. Non-shrink Grout: Master builders 928 or equal.

# 2.2 FABRICATION

- A. Verify dimensions on site and include in the shop drawings prior to shop fabrication.
- B. Fabricate items with joints tightly fitted and secured.
- C. Fit and shop assemble in largest practical sections, for delivery to jobsite.
- D. Grind exposed welds flush and smooth adjacent finished surfaces. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure, except where specifically noted otherwise.
- F. Make exposed joints butt tight, flush, and hairline.
- G. Supply components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

#### 2.3 FINISH

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact bond with concrete or where field welding is required.
- C. Prime paint interior items with one coat unless scheduled to be galvanized.
- D. Galvanize exterior items and scheduled interior items to minimum 2.00 oz/sq ft zinc coating.

# PART 3 – EXECUTION

#### 3.1 PREPARATION

- A. Obtain Architect's approval prior to site cutting or making adjustments not scheduled.
- B. Clean and strip primed steel items to bare metal where site welding is scheduled.
- C. Make provision for erection loads with temporary bracing. Keep work in alignment.
- D. Supply items required to be cast into concrete with setting templates, for installation under appropriate Sections.

### 3.2 FABRICATION

A. Unless indicated otherwise on the construction drawings, all steel is to be finish fabricated and provided with a hot-dip galvanized finish before delivery to the jobsite. See item 2.3-D above. Any alterations of final connections performed on site are to receive cold applied galvanizing touch-up paint.

#### 3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Perform field welding in accordance with AWS D1.1.
- C. After installation, touch-up field welds, scratched or damaged surfaces with primer, except repair exposed galvanized work (not to be painted) with hot process field galvanizing, in accord with manufacturer's published directions.

#### 3.4 SCHEDULE

- A. Provide and install items listed in Schedule and shown on Drawings with anchorage and attachment necessary for installation. The following Schedule lists principal items only. Refer to drawing details for items not specifically scheduled.
  - 1. Miscellaneous plates or angles not attached to structural steel; complete with anchorage for embedment
  - 2. Handrails and guardrails
  - 3. Jamb Guards for Roll-Up Doors
  - 4. Miscellaneous equipment support systems
  - 5. Catwalk support systems.

END OF SECTION

# SECTION 05 51 33

# METAL LADDERS

PART 1 – GENERAL

- 1.1 SECTION INCLUDES
  - A. Aluminum crossover ladders
  - B. Aluminum access ladders
  - C. Aluminum cage ladders

### 1.2 RELATED SECTIONS

- A. Section 05 05 19 Post-Installed Concrete Anchors
- B. Section 05 50 00 Metal Fabrication
- C. Section 05 53 00 Metal Grating
- D. Section 07 54 16 Ketone Ethylene Ester Roofing
- E. Section 07 56 00 Fluid-Applied Roofing
- F. Section 07 92 00 Joint Sealants
- G. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

#### 1.3 REFERENCES

- A. AA Aluminum Association
- B. ASTM B 209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C. ASTM B 221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- D. OSHA 1910.27 Fixed Ladders

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 23
- B. Product Data: Manufacturer's data sheets on each product.
- C. Shop Drawings:
  - 1. Detail fabrication and erection of each ladder indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.

- 2. Provide templates for anchors and bolts specified for installation.
- 3. Provide reaction loads for each hanger and bracket.
- D. Qualification Data:
  - 1. Refer to Section 01 45 00: Quality Control provisions for submittal requirements evidencing experience, certifications, and resources.
- E. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors.

### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project.
  - 1. Record of successful in-service performance.
  - 2. Sufficient production capacity to produce required units in a timely basis.
  - 3. Professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.
- B. Installer Qualifications: Competent and experienced firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.
- C. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation. Store in location out of the general flow of pedestrian and vehicular traffic.
- B. Contractor is responsible for unloading and relocating products from deliver truck to storage area and around site as directed by Owner or as required for sequencing construction.

#### 1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before submitting shop drawings and reverify prior to fabrication.

#### 1.8 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.

- 1. Defects in materials and workmanship.
- 2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.
- 3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective products.
- B. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

# PART 2 – PRODUCTS

# 2.1 MANUFACTURERS

- A. Basis of Design shall be O'Keeffe's, Inc.; 100 N Hill Drive, Suite 12, Brisbane, CA 94005. Toll Free Tel: (888) 653-3333. Tel: (415) 824-4900. Web: http://www.okeeffes.com.
- B. Acceptable alternate manufacturer's shall be: Alaco Ladder Co., Precision Ladders, LLC, or pre-approved equal.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 25 13: Product Substitution Procedures.

# 2.2 APPLICATIONS/SCOPE

- A. Fixed and Cage Ladder Design:
  - 1. Safety cages shall be provided as shown on the Construction Drawings and are required on ladders over 20 feet.
  - 2. Safety cages are required on all ladders in hazardous areas.
  - 3. Landing platforms are required at 50 feet above the bottom of the ladder.
  - 4. Ladder shall have the following brackets and points of attachment:
    - a. Bottom wall supported bracket 12" clear of the roof.
    - d. Wall bracket as drawn but in no case greater than 8'-0" center to center. Provide a minimum of 3 attachment points on each ladder.
    - c. Top wall support bracket within 12" of the upper roof surface.
    - d. Bottom floor supported bracket. Floor attachment only permitted at Generator Yard side of ladder.

- B. Cage Ladder:
  - 1. Cage Ladder with High Parapet Access, Platform, and Return.
    - a. Model 532 or 533 as manufactured by O'Keeffe's Inc.
- C. Fixed Access Ladder:
  - 1. Heavy Duty Tubular Rail.
    - a. Model 503 as manufactured by O'Keeffe's Inc.
  - 2. Tubular Rail Low Parapet Access Ladder with Roofover Rail Extension.
    - a. Model 502 as manufactured by O'Keeffe's Inc.
- D. Ship Ladder:
  - 1. Ship Ladder with Platform and Return
    - a. Model 522 as manufactured by O'Keeffe's Inc.
    - b. Stringer of equal or unequal length as required.
    - c. Platform length as required to span required conditions. Field verify.
  - 2. Incline:
    - a. 65 degree

# 2.3 FINISHES

A. Clear Anodic Finish: AA-M10C22A41 Mechanical finish as fabricated. Architectural Class I, clear coating 0.018 mm or thicker.

# 2.4 MATERIALS

- A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.
- B. Aluminum Extrusions: Alloy 6063-T6 to comply with ASTM B221.

# 2.5 FABRICATION FOR FIXED/ CAGE LADDERS

- A. Rungs: Not less than 1-1/4 inches (32 mm) in section and 18–3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
  - 1. Rungs shall withstand a 1,500 pound (454 kg) load without deformation or failure.
- B. Channel Side Rails: Not less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide.
- C. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide.

Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth, and burr-free surfaces.

- D. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.
- E. Security Doors: Formed 1/8 inch (3 mm) thick aluminum sheet. Security panels shall extend on both sides, perpendicular to the door face, to within 2 inches (51 mm) of the wall. Security door shall be furnished with continuous aluminum piano hinge and heavy duty forged steel locking hasps.
- F. Ladder Safety Post: Retractable hand hold and tie off. See Section 07 72 33: Roof Hatches.
- G. Safety Cages:
  - 1. Fabricate ladder safety cages to comply with authority having jurisdiction. Assemble by welding. Spacing of primary hoops, secondary hoops and vertical bars shall not exceed that required by code.
  - 2. Safety cage hoops and vertical bars: 3/16 inch (5 mm) by 2 inches (51 mm) aluminum bar.

#### 2.6 FABRICATION FOR SHIPS LADDERS / CROSSOVER

- A. Aluminum Ships Stair and Crossovers: Stair, mounting brackets and handrails on both sides.
  - 1. Model: 522, Aluminum Ships Stair
  - 2. Capacity: Unit shall support a 1,000 lb (454 kg) total load without failure.
  - 3. Degree of Incline: 60 to 75 degrees.
  - 4. Performance Standard: Units designed and manufactured to meet or exceed OSHA 1910.25.
- B. Components:
  - 1. Stair Stringer: 5 inch by 2 inch by 3/16 inch (127 mm by 51 mm by 5 mm) extruded 6005-T5 aluminum channel.
  - Stair Treads: 5-3/16 inch by 1-1/8 inch by 1/8 inch (131 mm by 29 mm by 3 mm) extruded 6005-T5 aluminum with serrated slip resistance surface standard. 1-1/4 inch by 1-1/4 by 1-1/4 inch angle welded to underside of treads. Treads shall be welded and bolted to stringer with 1/4" stainless steel bolts.
  - 3. Stair Mounting Brackets:
    - a. Floor Brackets: 2 inch by 3 inch by 1/4 inch (51 mm by 76 mm by 6 mm) aluminum angle.

- b. Top Bracket: 4-3/4 inch by 5 inch by 1/4 inch (121 mm by 127 mm by 6 mm) aluminum angle.
- 4. Handrails: 1-1/4 inches (32 mm) Schedule 40, 6005-T5 aluminum pipe provided with internal aluminum fittings.
- 5. Platform:
  - a. Surface: Platforms 9 Sq Ft or less shall be made of standard tread material. Platforms larger than 9 Sq Ft shall have a bar grating surface.
  - b. Toe Boards: 4 inch by 1/4" 6005 T-5 aluminum.
  - c. Handrails: 1-1/4 inches (32 mm) Schedule 40, 6005-T5 aluminum pipe provided with internal aluminum fittings.
- 6. Finishes:
  - a. Clear Anodized
- C. Options
  - 1. 42 inch handrail extension (walk-thru) for accessing platforms, landings or elevated work spaces.
  - 2. Crossover stairs with platform between two stairs.

# PART 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.
- B. Do not begin installation until supporting structure is complete and ladder installation will not interfere with supporting structure work.
- C. If supporting structure is the responsibility of another installer, notify Architect of unsatisfactory supporting work before proceeding.

#### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.
- 3.3 PROTECTION
  - A. Protect installed products until completion of project.
  - B. Touch-up, repair, or replace damaged products before Substantial Completion.

# SECTION 05 53 00

#### METAL GRATING

#### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

- A. Safety Grating walkways, planks, stair-treads with reticulated and formed metal cross struts.
- B. Regular and Heavy Duty Safety Grating products constructed from single-sheet with integrally-formed channels at the edges.
- C. Slip resistant walkways, planks and stair-treads with stamped surface textures/patterns.

#### 1.2 RELATED DOCUMENTS & SECTIONS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section. Other related sections include:
  - 1. Section 05 12 00 Structural Steel Framing
  - 2. Section 05 50 00 Metal Fabrication
  - 3. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

#### 1.3 SUBMITTALS

- A. Submit drawings of Safety Grating plank and tread products, accessories, and attachments.
- B. Submit manufacturer's product data on products including, but not limited to; types, materials, finishes, gauge thickness, surface patterns. For each grating cross-section, submit dimensional information, span, load capacity, and deflection requirements.
- C. Shop Drawings:
  - 1. Show fabrication and installation details, including plans.
  - 2. Coordination of drawings: Floor plans and sections, drawn to scale. Include scaled layout and relationships between grating and adjacent structural elements.

#### 1.4 REFERENCES

A. ASTM A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

- B. ASTM A 240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- C. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- D. ASTM A 924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- E. ASTM A 1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability
- F. ASTM B 209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- G. ASTM B 221 Aluminum Extruded Bars and Shapes
- H. ANSI/NAAMM- MBG-531-09 Metal Bar Grating Manual
- I. ANSI-NFSI B101.3-2012 Test Method for Measuring Wet Dynamic Coefficient of Friction (Wet DCOF) of Common Hard-Surface Floor Materials
- J. OSHA-Occupational Safety and Health Administration- Standards for walkingworking surfaces. Part Number 1910, Subpart D.
- K. RR-G-1602D- Federal Specification For Safety Grating (other than bar type & excluding naval vessels)
- L. ISO 9001:2000 Quality Management System Requirements.

### 1.5 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Grating of the types required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. OSHA Compliance: All grating installations must comply with OSHA Standards for walking-working surfaces.
- C. Federal Specification RR-G-1602D (or current revision) defines the criteria for items to be considered "Safety Grating". Slip resistant performance data must be available to support compliance.
- D. Manufacturer must have an ISO registered quality system in place, and Manual available upon request.
- 1.6 DELIVERY, STORAGE AND HANDLING
  - A. Deliver Grating and components carefully to avoid damage, denting, and scoring of finishes. Do not install damaged material.

B. Store materials in original packaging and in clean, dry space; protect from weather and construction traffic. Materials are to be elevated off of the ground by blocks, skids, or pallets.

## PART 2 – PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer List: Products of the following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules, and Specifications:
  - 1. McNichols <u>www.mcnichols.com</u>
  - 2. Grating Pacific <u>www.gratingpacific.com</u>
  - 3. Ohio Gratings <u>www.ohiogratings.com</u>
- B. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.
- 2.2 MATERIALS AND FINISH
  - A. Aluminum, Alloy 6061-T6 Extrusion and shall have a mill finish.
  - B. Steel, minimum 18 gauge and shall have a galvanizing finish equal to G60 or better.

#### 2.3 GRATINGS AND COMPONENTS

- A. Material similar to existing catwalk planking on site. All new or replacement planking shall be aluminum unless it is to blend with existing steel planking to remain.
  - Plank Grating, Extruded Interlocking Plank, equal to McNichols DIAMONDBACK®, Mill Finish aluminum, Diamond-Vented (12" Width), 2" Channel Depth with Dovetail Interlocking Slot, Diamond-Serrated Surface, Long Way of Opening (LWO) Parallel to Width of Extruded Interlocking Plank, Holes Sheared Through Both Ends of Extruded Interlocking Plank Parallel to Width of Extruded Interlocking Plank, 12% Open Area.
  - 2. Plank Grating, Interlocking Plank, equal to McNichols GRATE-LOCK®, Galvanized Steel, ASTM A-653, Mill Finish, 18 Gauge (.0516" Thick), Round-End Slot (12" Width), 2-1/2" Channel Depth, Two Male Channel Flanges, Male Channel Flange Profiles Interlock with Adjacent Female Channel Flange Profiles, Slip-Resistant Surface, Long way of Opening (LWO) Parallel to Width of Interlocking Plank, Slots Sheared Through Both Ends of Interlocking Plank Parallel to Width of Interlocking Plank, 45% Open Area.

# PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. Inspect areas to receive Grating for obstacles. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the areas. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Install Grating according to manufacturer's recommendations and as shown on the construction drawings.
- C. Position Grating sections flat and square with ends bearing minimum 1-1/2" on supporting structure.
- D. Keep sections at least 1/4" away from vertical steel sections and 1/2" from concrete walls.
- E. Allow clearance at joints between sections of maximum 1/4" at side channels and maximum 3/8" at ends.
- F. Band random cut ends and diagonal or circular cut exposed edges with a minimum 1/8" thick bar welded at contact points.
- G. Join abutting walkway sections with manufacturer supplied splice plates; bolted, or welded as specified.

# END OF SECTION

# SECTION 06 10 00

# ROUGH CARPENTRY

# PART 1 – GENERAL

#### 1.1 GENERAL REQUIREMENTS

A. The requirements of Division 01 apply to all Work of this Section.

#### 1.2 SCOPE

- A. Provide all labor, materials, tools, facilities, and equipment required for the fabrication and installation of rough carpentry and associated items (except that which is specified elsewhere) indicated on Drawings and necessary to complete the Work. Items include, but are not necessarily limited to, the following:
  - 1. Framing with dimension lumber
  - 2. Rooftop equipment bases and leveling curbs
  - 3. Wood nailers
  - 4. Wood furring
  - 5. Wood sleepers
  - 6. Plywood sheathing
  - 7. Preservative treatment
  - 8. Fire-retardant treatment of wood used within the roofing system
  - 9. Drilling, saw cuts, knock-outs, and framing for ventilation
- 1.3 RELATED WORK (See also Table of Contents)
  - A. Section 03 10 00 Concrete Formwork
  - B. Section 03 30 00 Cast-in-Place Concrete
  - C. Section 05 05 19 Post Installed Concrete Anchors
  - D. Section 05 12 00 Structural Steel
  - E. Section 05 40 00 Cold-Formed Metal Framing
  - F. Section 07 54 16 Ketone Ethylene Ester Roofing
  - G. Section 07 56 00 Fluid Applied Roofing
  - H. Section 07 95 00 Expansion control

# 1.4 QUALITY ASSURANCE

- A. General:
  - 1. Coordinate the work of all trades to ensure proper placement of all materials, anchors, etc., as well as providing for openings and anchors for the installation of surface mounted materials and equipment.
  - 2. Qualifications for Workmen: Provide sufficient skilled workmen and supervisors who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.
  - 3. Rejection: In the acceptance or rejection of rough carpentry, no allowance will be made for lack of skill on the part of the workmen.
- B. Standards and References: (Latest Edition unless otherwise noted)
  - 1. 2019 California Building Code (CBC)
  - 2. 2018 National Design Specification for Wood Construction (NDS)
  - 3. 2015 Special Design Provisions for Wind & Seismic (SDPWS)
  - 4. Lumber: West Coast Lumber Inspection Bureau (WCLIB); Standard Grading Rules for West Coast Lumber No. 17
  - 5. Lumber: Western Wood Products Association (WWPA); Western Lumber Grading Rules 05
  - 6. Redwood: Redwood Inspection Service (RIS); Standard Specifications for Grades of California Redwood Lumber
  - 7. Plywood Sheathing: The Engineered Wood Association; Specifications and Grades.
    - a. Structural Plywood: United States Product Standard PS1, Group 1 Douglas Fir
    - b. APA rated sheathing: United States Product Standard PS2.
  - 8. Wood Preservative: American Wood-Preservers' Association (AWPA):
    - a. U1, Use Category System: User Specification for Treated Wood
    - b. M4, Standard for the Care of Preservative-Treated Wood Products
  - 9. ASTM International (ASTM):
    - a. ASTM D3201 Standard Test Method For Hygroscopic Properties Of Fire-Retardant Wood And Wood-Based Products
    - b. ASTM E84 Standard Test Method For Surface Burning Characteristics Of Building Materials

ROUGH CARPENTRY 06 10 00 - 2

- C. Tests and Inspections
  - 1. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 2. If indicated on the Structural Drawings, load test expansion and epoxy anchors as indicated on the drawings.

# 1.5 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Material Certificates: For dimension lumber specified to comply with species and grade indicated on the plans.
- C. Evaluation Reports: For the following, from ICC-ES:
  - 1. Wood-preservative-treated wood
  - 2. Fire-retardant-treated wood
  - 3. Shear panels
  - 4. Power-driven fasteners

# 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protection:
  - 1. After delivery, store all materials off the ground, covered, and in such a manner as to ensure proper ventilation and drainage and to protect against damage and the weather. Maintain wood at the maximum moisture levels indicated in Materials Section.
  - 2. Keep all material clearly identified with all grade marks legible; keep all damaged material clearly identified as damaged, and separately store to prevent its inadvertent use. Do not allow installation of damaged or otherwise non-complying material.
  - 3. Use all means necessary to protect the installed work and materials of all other trades.
  - 4. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

# PART 2 – PRODUCTS

2.1 MATERIALS

- A. Sawn Lumber:
  - 1. Lumber (Wood Framing): Meet requirements of following minimum grades. All grades to WCLIB Grading Rules No. 17. Species shall be Douglas Fir Larch

<u>Item</u> All Material	<u>Sizes</u> 2x	<u>Grade</u> No. 1	Maximum Moisture <u>Content at Initial Use</u> 19%	<u>Notes</u> Unless Noted Otherwise
All Material	3x,4x	No. 1	19%	Unless Noted Otherwise
All Material	6x	No. 1	19%	Unless Noted Otherwise
Decking	2x	Select Dex	19%	

- 2. "At initial use" shall be that point at which nails, screws, bolts, split rings, shear plates or other fasteners or the holes for said fasteners are placed in the wood.
- 3. All sawn lumber is assumed to be enclosed in the dry building envelope in the final service condition, unless noted otherwise, and free to dry to moisture content less than 19%.
- 4. The Contractor shall use whatever means necessary, including site drying to ensure that the moisture contents above are not exceeded.
- 5. All studs, plates, joists, rafters and beams 3x and thicker shall be free of heart center in accordance with the specified grading standards.
- B. Plywood Sheathing:
  - 1. Roof and Wall Structural Sheathing: PS1 and PS2 APA rated sheathing with exterior glue. Thickness type and grade shall be as indicated on Drawings.
  - 2. Flooring: C-C APA Performance rated tongue and groove with exterior glue. Thickness type and grade shall be as indicated on the Drawings.
  - 3. Sheathing rated by agencies other than APA must be submitted for approval as a substitution.
- C. Building Paper: Fed. Spec. UU-B-790a, Type I, Grade B (15 lb. min. unless noted elsewhere.).
- D. Rough Hardware Fastenings and Connections: All types including bolts, lag screws, nails, spikes, screws, washers and other rough hardware, of kinds that may be purchased and that require no further fabrication, shall be furnished and installed for all finish and rough carpentry and shall conform to NDS Standards and dimensions. All hardware exposed to weather shall be hot-dipped galvanized per ASTM A153 Standards and CBC 2304.10.1.1. All nails used into pressure treated lumber shall be hot-dipped galvanized per ASTM A153 or stainless steel.

- 1. Common wire nails or spikes shall be used unless noted otherwise on the Drawings. Box nails and sinker nails are not permitted. Vinyl coating is permitted on nails when not exposed to weather. Nails and staples shall conform to requirements of CBC Section 2303.6.
- 2. Bolts: Bolt material shall conform to ASTM A307, Grade A. Bolt dimensions shall conform to ANSI/ASME B18.2.1 with hex head of sizes indicated.
- 3. Lag Screws: Lag screws shall conform to ASTM 307, Grade A. All lag screws shall have hex heads where exposed.
- 4. Washers: Standard flat washers shall conform to ANSI B18.22.1, Type A, Wide Pattern. Steel plate washers shall be Simpson BP or BPS or equivalent. Malleable iron washers shall be standard malleable iron washers.
- 5. Powder Driven Fasteners: Tempered steel pins with special corrosive resistant plating or coating. Pins shall have guide washers to accurately control penetration. Fastening shall be accomplished by low-velocity piston-driven power activated tool. Pins and tool shall be as manufactured by Hilti Fastening Systems or equivalent. See Drawings for size, type and embedment.
- 6. Expansion Anchors: See Section 03 25 00 for anchors to concrete.
- 7. Adhesive Anchors: See Section 05 05 19 for anchors to concrete.
- 8. Fabricated Metal Timber Framing Connectors: Connectors shall be punched for nailing and bolting. Nails and nailing shall conform to the manufacturer's instructions with a nail provided for each punched hole. All connectors must have specific ICC approval. Types as noted on Drawings are Simpson Strong-Tie. Hardware suppliers other than Simpson shall submit a comparative material list itemizing product designation, load rating and supported member size for review by the enforcement agency and the Structural Engineer.

# 2.2 FABRICATION

- A. Lumber:
  - 1. All lumber shall be air or kiln-dried to the maximum moisture content indicated in Materials Section.
  - 2. Furnish S4S unless otherwise noted.
  - 3. Size to conform to rules of governing standard. Sizes shown are nominal unless otherwise noted.
- B. Wood Treatment:
  - 1. Preservative Treatment: The treating process and results thereof shall conform to the appropriate AWPA Standards for exterior, above ground use (3B) and as indicated in CBC Section 2303.1.9.

- 2. After treatment and prior to shipping, air or kiln-dry lumber to maximum 19 percent moisture content.
- 3. All treated wood shall be identified with a label meeting the requirements of CBC Section 2303.1.9.1.
- 4. The amount of preservative to be injected into the wood shall be as required by the AWPA standard for each type of installation.
- 5. All wood in contact with concrete or masonry shall be preservative treated.
- 6. Cut surfaces and bored holes in pressure treated wood shall be protected in accordance with AWPA Standard M4.
- C. Fire Treatment: All fire-retardant-treated wood shall be identified with a label meeting the requirements of CBC Section 2303.2.4. The treating process and results thereof shall meet the requirements of CBC Section 2303.2. Moisture content of fire-retardant-treated wood shall meet CBC Section 2303.2.8. Treater shall submit design and fastener valves for treated wood to Structural Engineer for review. See Drawings for location of fire-retardant-treated wood.

### 2.3 FIRE RETARDANT PRESSURE TREATMENT OF LUMBER AND PLYWOOD

- A. Treatment: D-Blaze FRT as manufactured by Viance. Fire retardant treatment for wood, including blocking, nailers, furring, and studs.
  - 1. Lumber: Comply with AWPA U1 UCFA, Type A or ICC-ES ESR 2645
  - 2. Plywood: Comply with AWPA U1, UCFA, Type A or ICC-ES ESR 2645
  - 3. Surface Burning Characteristics: UL FR-S rating; or flame spread, and smoke developed ratings of 25 or less in a test of 30 minutes' duration in accordance with IBC section 2303.2.
  - 4. Kiln Dry after Treatment (KDAT): Provide kiln dry material as indicated or required.
    - a. Kiln dry after treatment to 19 percent maximum moisture content for lumber and 15 percent for plywood in accordance with AWPA T1, Section 7 - Drying After Treatment (lumber) and AWPA T1, Section: F: Pressure treated composites (3c) kiln drying after treatment.
  - 5. Fire-Retardant Treatment: Mark plywood and lumber to show compliance with specified standards.
  - 6. Low Chemical Emission Certification: GREENGUARD Gold Certified

### 2.4 SOURCE QUALITY CONTROL

A. Grade Mark each piece of lumber. Marking must be done by recognized agency.

- 1. Douglas Fir shall bear WCLIB or WWPA grade stamp.
- 2. Pressure treated Douglas Fir shall bear AWPA Quality mark.
- B. Wood Sheathing: Each panel shall be legibly identified as to type, grade and specie by APA grade. If plies are spliced, the slope of the scarf shall not be steeper than 1:8. White pockets will not be permitted in face plies.

# PART 3 – EXECUTION

#### 3.1 SURFACE CONDITIONS

- A. Inspection:
  - 1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly proceed.
  - 2. Verify that rough carpentry may be performed in strict accordance with the original design and all pertinent codes and regulations.
- B. Discrepancies: In the event of discrepancy, immediately notify Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

#### 3.2 WORKMANSHIP

- A. General: All rough carpentry shall produce joints true, tight, and well nailed with all members assembled in accordance with the Drawings and with all pertinent codes and regulations.
- B. Selection of Lumber Pieces: Carefully select all members. Select individual pieces so that knots and obvious defects will not interfere with placing bolts or proper nailing or making proper connections. Cut out and discard all defects which will render a piece unable to serve its intended function.
- C. Lumber may be rejected by the Architect, whether or not it has been installed, for excessive warp, twist, bow, crook, mildew, fungus, or mold, as well as for improper cutting and fitting.
- D. Shimming: do not shim any framing component.
- E. Care shall be taken that notching and boring of members is in strict conformance with the Drawings and that there are no over-cuts.

# 3.3 FASTENING

- A. Nailing: Except as otherwise indicated on Drawings or specified, all nailing shall be as required by CBC Table 2304.10.1 Fastening Schedule.
  - Nails or Spikes shall be common wire unless noted otherwise. Penetration of nails or spikes shall be one-half the length of the nail or spike into the piece receiving the point. However, to connect pieces 2" in thickness, 16d nails shall be used unless noted otherwise.

- a. Bore holes for nails wherever necessary to prevent splitting.
- b. Use finish or casing for finish work.
- c. Use of machine nailing is subject to a satisfactory installation of nails. Minimum edge distances shall be maintained. Nails installed through sheathing with nail guns shall not penetrate into the outer plies deeper than hand nailing. Submittal of guns and nails is required.
- d. All nailing into Pressure-Treated lumber shall utilize hot-dipped zinc coated galvanized nails or stainless steel nails per CBC Section 2304.10.5.
- B. Bolts and Lag Screws: Bolts shall be sizes indicated on Drawings. Holes for bolts shall be 1/16-inch larger than the bolt diameter. Malleable, Steel plate or standard flat washers shall be used where heads or nuts would otherwise bear directly on wood surfaces. Malleable or plate washers shall be used on all anchor bolts. Cut washers are not permitted. Lag screws shall be screwed (not driven) into place. For the shank, holes shall be bored the same depth and diameter as shank. For threaded portion, holes shall be pre-drilled as follows:

Lag Screw Size	Thread Portion Pre-Drill	
1/2" diameter	1/4" diameter	
5/8" diameter	5/16" diameter	
3/4 diameter	3/8" diameter	
7/8" diameter	1/2" diameter	
1" diameter	5/8" diameter	

Soap Lag screws prior to installation. Tighten all bolts and screws before closing in.

C. Framing Devices: Install according to the manufacturer's instructions unless otherwise noted.

#### 3.4 FRAMING AND ROUGH CARPENTRY

- A. Sills: Shall be in long lengths of sizes shown, fastened with anchor bolts as indicated, a minimum of two anchor bolts per piece. Place steel plate washers (but not standard flat or malleable iron washers) under nuts bearing on wood. Set sills level and true.
- B. Studs, Posts and Columns: Shall be full length. Corners shall be as detailed. Partitions or walls containing plumbing, heating or other piping shall be so formed as to give proper clearance for materials. Cut members as required to provide full bearing at ends. Connect to structure as indicated.
- C. Plates: Shall be full length of wall segment or 12-foot minimum and spliced as shown.
- D. Blocking: Blocking shall be same thickness and width of studs or joists unless shown otherwise. Blocking shall not be spaced over 8'-0" c.c. Install fire blocking in accordance with CBC. Horizontal fire blocking in walls shall be

placed at floor lines and ceiling lines unless noted otherwise. Install blocking at all plywood joints where noted on the Drawings. Install wall width full height solid blocking at floor joists beneath all posts in walls. Blocking shall be installed around all wall, floor and roof penetrations.

- E. Joists and Beams: Shall be full span length and spliced over bearings unless shown otherwise. Install with crown side up. Beams or headers indicated to be built up of two or more joists shall be fabricated on the job using full length members. For two piece 2x members, stitch nail pieces together with 16d common nails spaced not over 12 inches c.c. and staggered. Clinch nails protruding through members. For three or more piece members, stitch bolt pieces together with 1/2" bolts spaced not over 12 inches c.c. and staggered.
  - 1. Provide double joists and headers at all openings through roof unless otherwise shown on Drawings.
  - 2. Provide typical headers at all openings through walls where one or more studs are required to be cut. For penetration through walls narrower than stud spacing, provide solid blocking on all sides for fastening finish materials.
- F. Wood Sheathing: Install to pattern indicated and provide blocking at joints where noted on the Drawings. Center all joints over bearing supports. Nail to framing as indicated. Install wood sheathing with face plies perpendicular to joists unless indicated otherwise. Wall wood sheathing shall continue uninterrupted by ceilings or soffit from floor to floor or floor to roof unless specifically detailed on the Structural Drawings.
- G. Wood Furring, Stripping: Install as shown or required to provide nailing materials or passage of pipes, conduits, etc., not otherwise accommodated including ceiling stripping for gypsum drywall construction.
- H. Bridging: Space not over 8'-0" c.c. for spans over 16'-0". Joists 8 inches or less in depth shall not require bridging unless specifically indicated.
- I. Solid Wood Backing: Solid wood backing shall be provided for all wall and ceiling finishes and for supporting of mounted items for <u>all</u> trades, including but not limited to metal toilet partitions, toilet room accessories, frames, cabinets, casework, mirrors, trim, applied wall finishes, athletic equipment, food service equipment, piping, conduit, ducts, etc. Contractor shall coordinate placement of backing and supports with Subcontractor supplying mounted items.
- J. Building Paper: Install in all locations indicated except where included in other sections of the specifications.
- K. Cant Strips and Crickets: Shape to sizes shown. Rigidly fasten to construction. Form neat mitered corners.
- L. Wood Sheathing Backing: All toilet rooms, restrooms, single or joint occupancy shall have all walls backed with 5/8-inch thick wood sheathing with no surface voids. Install sheathing between the framing members and wallboard. The same wood sheathing shall also be provided and installed at all tile locations. At tile locations wood sheathing shall be installed between the framing members and the resin-cement backing board.

## 3.5 MISCELLANEOUS CARPENTRY WORK

- A. Install all items under other sections specified to be furnished and installed in other sections which relate to the rough carpentry work.
- B. Miscellaneous Carpentry Work not included under other sections but, indicated or required yet not specified elsewhere shall be furnished and installed hereunder, including appropriate fastening devices. Contractor shall provide miscellaneous carpentry work for all sections and divisions of work identified.
- C. Wood Curbs for Equipment: Construct all wood curbs for roof mounted equipment as detailed. Provide all miscellaneous blocking, bracing, supports, and other wood items as shown or required to complete the work.
- D. Plywood Backing for Electrical, telephone, and similar types of wall mounted equipment shall be provided hereunder where required. Plywood shall be 3/4-inch thick exterior A-C plywood with 'A' face exposed.
- E. Fire/Draft Stops: Construct fire and drafts stops in furred attic spaces where indicated or required by CBC code. Unless otherwise indicated on Drawings construct of not less than 5/8-inch Type 'X' gypsum wallboard or 1/2" wood sheathing, adequately supported by 2x4's at 24 inches c.c., braced diagonally to the roof structure. Draft stop and installation work shall conform to code requirements.
- F. Shoring and Bracing: Shore or brace for temporary support of all work as required during the construction period except any shoring and bracing specified and included under other sections of these specifications.
- G. Temporary Enclosures: Provide and maintain all barricades and enclosures required to protect the work in progress.
- H. Protect all work in progress and all work installed, as well as the work of all other trades. Any work damaged as a result of the work under this section shall be corrected to its original condition or replaced if directed by the Architect at no increase in cost to the Owner.
- J. Ventilation: Contractor shall include all labor and materials necessary to provide ventilation requirements of roof overhangs, eaves, attics, and all other components of the building required by codes to be ventilated. Work shall include removing knock-outs in wood I-joists for cross ventilation, drilling of blocking, wood sheathing, and other wooden components of the structure necessary to comply with requirements of the CBC for ventilation of buildings.

END OF SECTION

# SECTION 06 16 43

## GYPSUM SHEATHING

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

- A. This Section includes gypsum sheathing assemblies for the exterior walls.
- B. Fire-test-response characteristics: Where fire-resistance-rated gypsum sheating assemblies are indicated, provide gypsum sheathing assemblies that are identical to assemblies tested for fire resistance according to ASTM E 119.

#### 1.2 RELATED SECTIONS

- A. Section 05 40 00 Cold-Formed Metal Framing
- B. Section 06 10 00 Rough Carpentry
- C. Section 07 54 16 Ketone Ethylene Ester Roofing
- D. Section 07 56 00 Fluid-Applied Roofing
- E. Section 07 60 00 Flashing & Sheet Metal
- F. Section 07 92 00 Joint Sealant

#### 1.3 SUBMITTALS

- A. Submit under provisions of Section 01 33 23 Shop Drawings, Product Data, and Samples. Submit product data.
- B. Provide the Manufacturers' certification that products containing VOC's meet all local regulations controlling the use of VOC's.
- C. Provide details of fire rated assemblies as required per contract drawings.

#### 1.4 QUALITY ASSURANCE

A. Comply with Federal Specification SS – L – 30b and ASTM C36.67.

#### PART 2 – PRODUCTS

- 2.1 MANUFACTURERS
  - A. Subject to compliance with requirements, all products shall be from a single manufacturer from the following list:
    - 1. Gypsum Sheathing and Related Products:
      - a. National Gypsum Co.; Gold Bond Building Products Division
      - b. Georgia-Pacific Corp.

- c. United States Gypsum Co.
- d. Or equal

# 2.2 EXTENDED EXPOSURE GYPSUM SHEATHING

- A. Description
  - 1. Core: regular gypsum core with additives to enhance fire resistance, moisture, and mold resistant
  - 2. Facing: Water-resistant glass mat on both face and back surfaces
  - 3. Long Edges: Wrapped with water-repellant glass mat
  - 4. Overall thickness: 1/2 inch
- B. Panel Physical Characteristics
  - 1. Panel complies with requirements of both ASTM C 1177/C1177M and C1396/C1396M
  - 2. Classification: Type X, when tested in accordance with ASTM E 119
  - 3. Racking Strength Ultimate: 617 lbs/lin ft. when tested in accordance with ASTM E72
  - 4. Flexural Strength Parallel: 80 lbs, when tested in accordance with ASTM C473
  - 5. Humidified Deflection: less than 1/8 inch when tested in accordance with ASTM C473
  - 6. Nail pull resistance: 80 lbs, when tested in accordance with ASTM C473
  - 7. Water Absorption: less than 10% when tested in accordance with ASTM C473
  - 8. Surface Water Absorption: less than 1% when tested in accordance with ASTM C473
  - 9. Permeance: greater than 10 perms, when tested in accordance with ASTM E96
  - 10. Combustibility: Noncombustible when tested in accordance with ASTM E136
  - 11. Flame spreads/Smoke Developed: 5/0 when tested in accordance with ASTM E84
  - 12. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273

# PART 3 - EXECUTION

# 3.1 GYPSUM SHEATHING INSTALLATION

#### A. General:

- 1. Install in accordance with manufacturer recommendations, ASTM C1280, and GA-253
- 2. Apply extended exposure gypsum sheathing horizontally to metal framing
- 3. Factory finished edging shall run continuous along top edge of installation.

# END OF SECTION

# SECTION 06 81 13

## GLASS-FIBER-REINFORCED PLASTIC RAILINGS

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

A. This specification is for a pultruded fiberglass railing system in compliance with 2012 IBC, and OSHA 1910.23.

#### 1.2 REFERENCES

- A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.
- B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:
  - 1. ASTM D-638-Tensile Properties of Plastics
  - 2. ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics
  - 3. ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
  - 4. ASTM D-495-High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation
  - 5. ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics
  - 6. ASTM E-84-Surface Burning Characteristics of Building Materials
- C. INTERNATIONAL CODE COUNCIL, INC. The International Building Code, 2021
- D. THE OCCUPATIONAL HEALTH AND SAFETY ADMINISTRATION Code of Federal Regulations (CFR), Title 29, Section 1910.23

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish shop drawings of all fabricated railings and accessories in accordance with the provisions of this Section.
- B. Furnish manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
- C. Submit the manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.

#### 1.4 QUALITY ASSURANCE

- Α. All items to be provided under this Section shall be furnished by a single manufacturers having a minimum of ten (10) years' experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
- Β. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
- C. Manufacturer shall be certified to the ISO 9001-2008 standard.

#### 1.5 PRODUCT DELIVERY AND STORAGE

- Α. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- Β. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

#### PART 2 – PRODUCTS

#### 2.1 MANUFACTURERS

- Manufacturer List: Products of following manufacturers are acceptable subject to Α. conformance to requirements of Drawings, Schedules and Specifications:
  - Fibergrate Composite Structures Inc.; 5151 Belt Line Road, Suite 1212, 1. Dallas, Texas 75254-7028; (800) 527 4043; www.fibergrate.com
  - Strongwell: 400 Commonwealth Ave., Bristol, Virginia 24201: (276) 645-2. 8000: www.strongwell.com
  - Bedford Reinforced Plastics: One Corporate Drive, Suite 106, Bedford, 3. PA 15522; (814) 623-8125; www.bedfordreinforced.com
- Β. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.

#### 2.2 MATERIALS

- Basis of design shall be DYNAFORM® FRP structural shapes manufactured by Α. the pultrusion process. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions specified in the Contract Documents.
- B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

- C. Resins shall be ISOFR, fire retardant isophthalic polyester with chemical formulation necessary to provide the corrosion resistance, strength, and other physical properties as required.
- D. All finished surfaces of FRP items and fabrications shall be smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- E. All pultruded structural shapes shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin, 2) a synthetic surfacing veil to help produce a resin rich surface, and 3) an appropriate UV resistant coating for outdoor exposures.
- F. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E 84 Tunnel Test.
- G. Top and bottom rails for guards are to be 1.75" x 0.125" (44.4 mm x 3.2 mm) wall square tube, the posts are to be 2.125" x 0.1875" (53.9 mm x 4.8 mm) wall square tube and kick plate is to be 1/2" deep x 4" wide with two reinforcing ribs. Offset rail used as handrail to be 1.5" x 0.25" (38.1 mm x 6.4 mm) wall round tube.
- H. The completed railing installation shall meet the following load requirements with a minimum factor of safety of 2.0:
  - 1. Concentrated Load: 200 lb (891 N) applied in any direction at any point on the rail.
  - 2. Uniform Load: 50 lb/lf (730.5 N/m) applied in any direction on the rail.
  - 3. Loads are assumed not to act concurrently.
- I. All rails, posts, and kick plates are to be integrally pigmented yellow.
- J. Pultruded structural shapes used in the railing systems are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Method	Value	Units
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5 x 106 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8 x 106 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8 x 106 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5 x 105 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	8.0 x 10-6	
		(1.4 x 10 -6)	in/in/°F
(cm/cm/°C)			
Flame Spread	E-84	25 or less	N/A

K. All fasteners used in the railing system are to be 316 SS. Rivets to be 18-8 SS.

## PART 3 - EXECUTION

#### 3.1 PREPARATION:

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from infiltration of water and debris.
- 3.2 INSPECTION AND TESTING:
  - A. The Design Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.
  - B. All labor, power, materials, equipment, and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.
- 3.3 INSTALLATION, GENERAL:
  - A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by the Design Engineer.
  - B. Cutting, fitting and placement: Perform cutting, drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.
  - C. Provide temporary bracing or anchors in form work for items that are to be built into concrete masonry or similar construction.

# 3.4 ALL FRP INSTALLATION:

- A. If required, all field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer.
- B. Install items specified as indicated and in accordance with manufacturer's instructions.

# END OF SECTION

# SECTION 07 19 16

# SILANE WATER REPELLENTS

#### PART 1 – GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Water based Silane/Siloxane water repellent sealer for split-faced, lightweight and standard CMU as scheduled
  - B. Related Sections:
    - 1. Section 03 30 00 Cast-in-Place Concrete
    - 2. Section 04 22 00 Concrete Unit Masonry
    - 3. Section 07 92 00 Joint Sealants

#### 1.2 SUBMITTALS

- A. Submit under provisions of Section 01 33 00
- B. Product Data: Submit manufacturer's technical bulletins and MSDS on each product.
- C. Submit list of project references as documented in this Specification under Quality Assurance Article. Include contact name and phone number of person charged with oversight of each project.
- D. Quality Control Submittals:
  - 1. Provide protection plan of surrounding areas and non-work surfaces.

#### 1.3 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Manufacturer Qualifications: Company with minimum 15 years of experience in manufacturing of specified products and systems.
  - 2. Manufacturer Qualifications: Company shall be ISO 9001:2000 Certified.
  - 3. Applicator Qualifications: Company with minimum of 5 years' experience in application of specified products and systems on projects of similar size and scope, and is acceptable to product manufacturer.
    - a. Successful completion of a minimum of 5 projects of similar size and complexity to specified Work.
- C. Field Sample:
- 1. Designate and area at Project site or pre-selected area of building, an area for field sample, as directed by Site.
  - a. Provide mock-up of at least 25 square feet (2.3 sq.m) to include surface preparation, sealant joint, and juncture details and allow for evaluation of repellent performance and finish.
  - b. Conduct RILEM test on cured field sample. Allow product to fully cure 5 to 7 days before testing. Adjust application until required repellent performance is achieved.
  - c. Apply material in strict accordance with manufacturer's written application instructions.
- 2. Manufacturer's representative or designated representative will review technical aspects; surface preparation, application, and workmanship.
- 3. Field sample will be standard for judging workmanship on remainder of Project.
- 4. Maintain field sample during construction for workmanship comparison.
- 5. Do not alter, move, or destroy field sample until Work is completed and approved by Architect.
- 6. Obtain Architect's written approval of field sample before start of material application, including approval of aesthetics, color, texture, and appearance.
- 1.4 DELIVERY, STORAGE, AND HANDLING
  - A. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
  - B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
  - C. Store in unopened containers in a cool, dry area. Keep material from freezing in the container; do not store below 35 degree F (2 degree C) or above 100 degrees F (43 degrees C).

## 1.5 PROJECT CONDITIONS

- A. Environmental Requirements:
  - 1. Minimum application temperature is 40 degrees F (4 degrees C) and rising.
  - 2. Do not apply in rain or when inclement weather is expected within 12 hours. Do not apply below 40 degrees F (4 degrees C) or when temperatures are expected to fall below 40 degrees F (4 degrees C) within 4 hours.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer List: Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules, and Specifications:
  - 1. Master Builders Solutions; 889 Valley Park Drive, Shakopee, MN 55379; (800) 433-9517; <u>www.master-builders-solutions.com/en-us</u>
  - 2. Prosoco, Inc.; 3741 Greenway Circle, Lawrence, KS 66046; (800) 255-4255; <u>www.prosoco.com</u>
  - 3. Chemical Products Industries, Inc.; 7649 SW 34<sup>th</sup> St., Oklahoma City, OK 73179; (900) 624-4356; <u>www.chemicalproductsokc.com</u>
- B. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.

### 2.2 MATERIALS

- A. Basis of design shall be MasterProtect H 185 as manufactured by Master Builders Solutions. A water-based, clear, silane/siloxane sealer designed to provide protection for split-faced, lightweight, and standard CMU.
- B. Water repellent material shall have the following minimum performance:
  - 1. Flash point: > 212 degree F (> 100 degree C) per ASTM D 3278
  - 2. VOC content: < 2.50 lb/gl (< 300 g/L) per EPA Method 24
  - 3. Water repellency in water absorption: 95 percent reduction in weight gain per ASTM C 140
  - 4. Water repellency in leakage on block wall: 99 percent reduction in weight gain per ASTM C 514

#### PART 3 - EXECUTION

### 3.2 SURFACE PREPARATION

- A. Surfaces shall be clean, structurally sound, and fully cured (28 days). Remove all dust, dirt, paint, bitumens, efflorescence, oil, pollution deposits, and curing, forming, and parting compounds.
- B. Complete caulking, pointing, and restoration work before applying water repellent. Allow to cure.
- C. Treat and remove alkali and efflorescence with proper neutralizing compound recommended by concrete or block supplier or distributor.
- D. Protect plant life and surfaces to remain uncoated during application. Use drop cloths or masking as required.

E. Using cardboard template, temporarily cover surfaces like windows, doors, or louvers during application of sealer or follow requirements in Cleaning Article.

### 3.3 APPLICATION

- A. Surface, air, and material temperatures shall be 40 degree F (4 degree C) or above prior to and during the application. Do not apply if rain is expected within 12 hours following application.
- B. Stir product thoroughly prior to and periodically during use. Do not dilute.
- C. Apply by low-pressure, non-atomizing spray starting from the bottom up.
- D. Apply a mist coat immediately prior to application to help break surface tension, ensuring maximum penetration of the sealer.
- E. Flood surfaces to saturation by applying from the bottom up with a controlled 8 to 10 inches (20 cm) material rundown to ensure maximum penetration into substrate.
- F. Provide 2 coat applications on all concrete block. Application of the second coat shall proceed with a wet-on-wet application.

#### 3.4 CLEANING

- A. Clean equipment and tools with hot soapy water. Overspray can be cleaned immediately with hot, soapy water. Dried residue can be cleaned with citrus degreaser.
- B. Wipe windows with dampened cloth or sponge immediately following application of sealer.
- C. Clean up and properly dispose of debris remaining on Project site related to application.
- D. Remove temporary coverings and protection from adjacent Work areas.

## 3.5 PROTECTION

A. Protect system from damage during construction

## END OF SECTION

## SECTION 07 22 00

## ROOF AND DECK INSULATION

### PART 1 – GENERAL

- 1.1 SECTION INCLUDES
  - A. Flat and Tapered Polyiso Roof Insulation
    - 1. Faced with non-asphaltic, fiber-reinforced cellulosic organic felt facers on both major surfaces of the core foam (GRF).

### 1.2 RELATED SECTIONS

- A. Section 05 30 00 Metal Decking
- B. Section 05 40 00 Cold-Formed Metal Framing
- C. Section 06 10 00 Rough Carpentry
- D. Section 07 54 16 Ketone Ethylene Ester Roofing
- E. Section 07 56 00 Fluid Applied Roofing

#### 1.3 REFERENCES

- A. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.
- B. ASTM D312 Standard Specification for Asphalt Used in Roofing.
- C. ASTM E108 Standard Test Methods for Fire Tests or Roof Coverings.
- D. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
- E. FM 4450 Approval Standard Class I Insulated Steel Roof Decks
- F. FM 4470 Approval Standard Class I Roof Covers.
- G. LTTR Long Term Thermal Resistance predicated by CAN/ULC-S770-09.
- H. UL 263Fire Tests of Building Construction and Materials.
- I UL 790Standard Test Methods for Fire Tests of Roof Coverings.
- J. UL 1256 Fire Test Methods for Fire Tests of Roof Coverings.
- K. ASTM E2114 Standard Terminology for Sustainability Relative to the Performance of Buildings.
- L. ASTM E2129 Standard Practice for Data Collection for Sustainability Assessment of Building Products.

### 1.4 DEFINITIONS

A. LTTR (Long Term Thermal Resistance): Defined as using techniques from ASTM C1303 or CAN/ULC-S770-09, the predicated R-Value that has been shown to be equivalent to the average performance of a permeably faced foam insulation product over 15 years. LTTR applies to ALL foam insulation products with blowing agents other than air, such as Polyiso, extruded polystyrene and polyurethane. The new method is based on consensus standards in the US and Canada.

### 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 23 Shop Drawings, Product Data, and Samples and 01 25 00 Substitutions Procedures.
- B. Product Data:
  - 1. Manufacturer's Specifications
  - 2. Installation instructions for insulation board and fasteners
  - 3. Product Data as per ASTM E2129: Standard Practice for Data Collection for Sustainability Assessment of Building Products
- C. Samples:
  - 1. Not Required
- D. Shop Drawings:
  - 1. Roof plan showing layout of boards, tapered boards, and fastening patterns.
- E. Certificates:
  - 1. System Manufacturer's or Insulation Manufacturer's Certification that the insulation meets Zero ODP (Ozone Depletion Potential) and Zero GWP (Global Warming Potential) specification requirements.
- F. Thermal Warranty:
  - 1. Submit sample warranty indicating conditions and limitations.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum twenty-five years documented experience.
- B. Installer Qualifications: Company specializing in the installation of products specified in this section with minimum 5 years documented experience in installing products of the same type and scope as specified.

C. Warranty: Manufacturer and Installer of this insulation board material must coordinate with and be identified in the Warranty information for the full roofing system. Refer to Sections 07 54 16 and 07 56 00 for additional information.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product in packages labeled with material name, thermal value, and product code.
- B. When stored outdoors or on the jobsite, the insulation should be stacked on pallets at least three inches above ground level and completely covered with a waterproof covering such as a tarpaulin. The temporary factory-applied packaging should be slit or removed to prevent accumulation of condensation. Insulation which has become wet or damaged should be removed and replaced with solid, dry insulation.

#### 1.8 SEQUENCING

- A. Ensure that information required for installation of products in this section is furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.
- C. Coordinate installation with roof membrane manufacturer's installation instructions.

#### 1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## PART 2 – PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer List: Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules, and Specifications:
  - 1. Tremco Roofing & Building Maintenance, 3735 Green Road, Beachwood, Ohio 44122; phone: 800.562.2728; web: tremcoroofing.com
  - 2. Atlas Roofing Corporation; 2000 Riveredge Parkway Suite 800, Atlanta, GA 30328; phone: 800-388-6134; web: <u>www.atlasrwi.com</u>
  - 3. Johns Manville; 5916 County Road 49, Willows, CA 95988; phone: 1-530-934-7761; web: jm.com
- B. Substitutions: Submit substitutions under section 01 25 00 Substitution Procedures.

### 2.2 MATERIALS

- A. Roof Insulation panel (base panel): Polyisocyanurate board insulation, ASTM C1289 Type II Class 1 CFC- and HCFC- free, with recycled content glass-fiber mat facer on both major surfaces. The Basis of design product shall be Tremco, Trisotech Insulation
  - 1. Compliance:
    - a. ASTM C1289, Type II, Class 1, Grade 3 (25 psi)
    - UL Standard 1256 Classification: Construction No. 120, 123 & 292
    - c. UL Standard 790 (ASTM E108): Roofing Systems Classification
    - d. UL Standard 263 (ASTM E119): Fire Resistance Classification
    - e. UL Standard 1897: Uplift Resistance
    - f. FM Standard 4450 & 4470 Approved: Refer to FM Approvals ® RoofNav for Specific Systems Details
    - g. California State Insulation Quality Standards
    - h. Title 25 Foam Flammability Criteria (T 1231)
    - i. Dimensional Stability (ASTM D2126): <2%
    - j. Compressive Strength (ASTM D1621): 20 psi (140 kPa) or 25 psi (172 kPa)
    - k. Water Absorption (ASTM C209): <1.5%
    - I. Water Absorption (ASTM D2842): <3.5%
    - m. Water Vapor Transmission (ASTM E96): <1.5 perm (85.5ng/(Pa•s•m2))
    - n. Product Density (ASTM D1622): Nominal 2.0 pcf (32.04 kg/m3)
    - o. Flame Spread (ASTM E84 10 min.): 40-60
    - p. Smoke Development (ASTM E84 10 min.): 50-170
    - q. Tensile Strength (ASTM D1623): >730 psf (35 kPa)
    - r. Service Temperature: -100°F to +250°F
    - s. Panel Area:
      - 1) 4 foot by 8 foot
      - 2) 4 foot by 4 foot

## ROOF AND DECK INSULATION 07 22 00 - 4

- t. Panel Thickness:
  - 1) 1.5 inch: LTTR 8.55
- B. Tapered Insulation panels: Factory tapered panels of type equal to the base panels above.
  - 1. Basic panel size: 4 foot by 4 foot
  - 2. Panel Thickness:
    - a. Slope: 1/4 inch per foot
    - b. Minimum Thickness: 1/8 inches
    - c. Maximum Thickness: 4.0 inches
- C. Pre-Cut Cricket: pre-cut tapered polyisocyanurate (polyiso) roof insulation fabricated of factory cut and hinged triangular shaped of factory tapered panels equal to the base panel.
  - 1. Triangular Panel Area: Applies to flat and tapered pre-cut cricket panels.
    - a. Length: 4 foot
    - b. Width: 12 foot
  - 2. Tapered Panel Thickness:
    - a. Slope: 1/4" per ft.
    - b. Minimum Thickness: 1/8 inch
    - c. Maximum Thickness: 2.0 inches
- C. Roof Insulation Adhesive:
  - 1. Cold fluid-applied bead-applied low-rise adhesive, two-component solvent-free low odor elastomeric urethane, formulated to adhere roof insulation to substrate.
    - a. Basis of design product: Tremco, Low Rise Foam Insulation Adhesive.
    - b. Flame Spread Index, ASTM E84: 10
    - c. Smoke Developed Index, ASTM E84: 30
    - Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L
    - e. Tensile Strength, minimum, ASTM D412: 250 psi (1724 kPa)
    - f. Peel Adhesion, minimum, ASTM D903: 17 lbf/in (2.98 kN/m)

ROOF AND DECK INSULATION

g. Flexibility, 70 deg. F (39 deg. C), ASTM D816: Pass

## PART 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Examine roof deck for suitability to receive insulation.
- B. Verify that substrate is dry, clean and free of foreign material that will damage insulation or impede installation.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Verify that roof drains, scuppers, roof curbs, nailers, equipment supports, vents and other roof accessories are secured properly and installed in conformance with Contract Documents.
- E. Verify that deck is structurally sound to support installers, materials and equipment without damaging or deforming work.
  - 1. Start of installation indicates installer accepts conditions of existing deck surfaces.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Verify the manufacturer's roof edge details for accuracy to fit the assembly.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Install specified insulation using approved mechanical fasteners or adhesives in accordance with manufacturer's latest written instructions and as required by governing codes and State of California's insurance carrier.

### C. Insulation shall be installed in a continuous layer of 1.5" for a minimum R-Value of 8. Tapered insulation shall be installed over continuous layer. Exceptions to the continuous layer shall be a roof drain sumps where the continuous layer shall be tapered to zero at the drain perimeter.

D. Install with end joints staggered to avoid having insulation joints coinciding with joints in deck. In multi-layer installations, stagger joints in top and bottom layers.

#### 3.4 PROTECTION

A. Remove trash and construction debris from insulation surface prior to application of roofing membrane.

- B. Do not leave installed insulation exposed to weather. Cover and waterproof completed roof system immediately after installation.
  - 1. Temporarily seal exposed insulation edges at the end of each day.
  - 2. Remove and replace installed insulation that has become wet or damaged with new insulation.
- C. Protect installed insulation and roof cover from traffic by use of protective covering materials during and after installation.

END OF SECTION

## SECTION 07 54 16

## KETONE ETHYLENE ESTER (KEE) ROOFING

### 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. Adhered thermoplastic KEE roofing system on concrete deck, including:
  - 2. Roof insulation
  - 3. Roof insulation cover board
  - 4. Walkway material
  - 5. Field fabricated flashings
- B. Related Sections:
  - 1. Section 03 30 00 Cast-in-Place Concrete
  - 2. Section 05 05 19 Post-Installed Concrete Anchors
  - 3. Section 05 40 00 Cold-Formed Metal Framing
  - 4. Section 05 50 00 Metal Fabrication
  - 5. Section 06 10 00 Rough Carpentry
  - 6. Section 07 22 00 Roof and Deck Insulation
  - 7. Section 07 56 00 Fluid Applied Roofing
  - 8. Section 07 60 00 Flashing and Sheet Metal
  - 9. Section 07 72 00 Roof Accessories
  - 10. Section 07 92 00 Joint Sealants
  - 11. Section 07 95 00 Expansion Control
  - 12. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

### 1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 "Standard Terminology Relating to Roofing and Waterproofing" and glossary in applicable edition of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" for definition of terms related to roofing work in this Section.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  - 2. Review drawings and specifications.
  - 3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 5. Examine substrate conditions and finishes for compliance with requirements, including flatness and fastening.
  - 6. Review structural loading limitations of roof deck during and after roofing.
  - 7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
  - 8. Review governing regulations and requirements for insurance and certificates if applicable.
  - 9. Review temporary protection requirements for roofing system during and after installation.
  - 10. Review roof observation and repair procedures after roofing installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Samples for Verification: For the following products:
  - 1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
  - 2. Walkway pads or rolls.

3. Metal termination bars.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Product Certificate: Submit certificate, indicating products intended for Work of this Section, including product names and numbers and manufacturers' names, with statement indicating that products to be provided meet the requirements of the Contract Documents.
- B. Warranties: Unexecuted sample copies of special warranties.
- C. Inspection Reports: Reports of Roofing Inspector. Include weather conditions, description of work performed, tests performed, defective work observed, and corrective actions taken to correct defective work.
  - 1. Submit reports within 24 hours after inspection.

### 1.7 CLOSEOUT SUBMITTALS

- A. Executed copies of warranties
- B. Maintenance Data: To include in maintenance manuals
- 1.8 QUALITY ASSURANCE
  - A. Installer Qualifications: An employer of workers trained and certified by manufacturer, including a full-time on-site supervisor with a minimum of five years' experience installing products specified, able to communicate verbally with Contractor, Architect, and employees, and qualified by the manufacturer to install products of the full roofing system and furnish warranty of type specified.
  - B. Manufacturer Qualifications: Approved manufacturer listed in this Section, UL listed and FM Global approved for roofing systems specified for this Project, with minimum fifteen years' experience in manufacture of thermoplastic roof membrane products in successful use in similar applications. The manufacturer of this single ply product shall also meet all of the qualifications of Section 07 56 00 Fluid Applied Roofing.
    - 1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review. But in no case will a substitution be reviewed within 15 business days of the scheduled bid date.:
      - a. Substitution requests must be submitted by a California licensed roofing contractor that can show prior evidence of being a manufacturer's certified installer.
      - b. Product data, including certified independent test data indicating compliance with requirements.
      - c. Physical samples of each component being substituted
      - d. Sample submittal from similar project

- e. Project references: Minimum of five installations of specified products not less than five years old, with Owner and Architect contact information. References must be for the submitting contractor using the substituted materials.
- f. Sample warranty covering the full system with all components
- g. Any product submitted for use on this project must comply with CEC 141.0(b)2Bi "Low-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75".
- 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
- C. Roofing Inspector Qualifications: A technical representative of the manufacturer who is not engaged in the sale of products and experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
  - 1. An authorized full-time technical employee of the manufacturer.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site access to manufacturer's written recommendations and instructions for installation of products.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- 1.10 PROJECT / FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
  - 1. Provide tie-offs at end of each day's work to cover exposed roofing and insulation with a course of roofing sheet securely in place with joints and edges sealed.
  - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
  - 3. Remove temporary plugs from roof drains at end of each day.
  - 4. Remove and discard temporary seals before beginning work on adjoining roofing.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Roof System Manufacturer's standard form in which Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within warranty period, as follows.
  - 1. Form of Warranty: Manufacturer's standard warranty form.
  - 2. Scope of Warranty: Work of this Section and including sheet metal details and termination details installed by the roof system Installer and approved by the Roof System Manufacturer.
    - a. Insulation materials, fasteners, and adhesives.
    - b. All new and temporary roof membrane components and adhesives.
    - c. All metal edge components including cleat strips.
    - d. All tapered edge and cant strips.
    - e. All surface mastics, coatings, stripping, plies, etc.
    - f. All drain and scupper flashing.
    - g. Any roof leak or other problems caused by substrate movement of any component other than the deck shall not be excluded.
    - h. Any movement associated with metal edge joints of flanges causing leaks.
    - i. Damages caused by wind speed up to 74 miles per hour.

- j. Permanent tie-ins and/or control joints separating new and old roofing.
- 3. One Manufacturer will provide Warranty for both single ply and specified fluid-applied roof systems.
- 4. Warranty Period: 30 years from date of completion.
- B. Manufacturer Inspection Services: By manufacturer's technical representative, to report maintenance responsibilities to Owner necessary for preservation of Owner's warranty rights. The cost of manufacturer's inspections is included in the Contract Sum.
  - 1. Inspections to occur in the following years after the Notice of completion: 2, 5, 10, 15, 20, and 25 following completion.
- C. Installer Warranty: Installer's warranty signed by Installer, as follows.
  - 1. Form of Warranty: Form acceptable to Roofing Manufacturer and Owner.
  - 2. Scope of Warranty: Work of this Section and of others as specified herein.
  - 3. Warranty Period: 2 years from date of completion.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS

- A. Basis of Design: The roof system specified in this Section is based upon products of Tremco, Inc., Beachwood, OH or pre-approved equal.
- B. Source Limitations: Obtain components for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer. Manufacturer of the membrane roofing shall be the same manufacturer of the fluid applied roofing identified in section 07 56 00.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Flashings and Fastening: Provide base flashings, perimeter flashings, detail flashings and component materials and installation techniques that comply with requirements and recommendations of the following:
  - 1. FM Global 1-49: Loss Prevention Data Sheet for Perimeter Flashings
  - 2. FM Global 1-29: Loss Prevention Data Sheet for Above Deck Roof Components

- 3. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations
- 4. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details
- 5. Comply with requirements of Section 07 60 00 Flashing and Sheet Metal for trim and roof Specialties.
- C. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- D. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated on Drawings. Identify products with appropriate markings of applicable testing agency.
  - Indicate design designations from UL's "Fire Resistance Directory" or 1. from the listings of another gualified testing agency.
- E. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- F. Energy Performance: Roofing system shall have an initial solar reflectance index of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.
- 2.3 MATERIALS, GENERAL
  - Material Compatibility: Roofing materials shall be compatible with one another Α. and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- 2.4 THERMOPLASTIC MEMBRANE MATERIALS
  - Α. KEE Roof Membrane:
  - 1. Thermoplastic Ketone Ethylene Ester (KEE) coated polyester fabric-reinforced fleece-backed roof membrane sheet. ASTM D6754.
    - Basis of design product: Tremco, TremPly KEE FB Single Ply Roof a. Membrane
    - Breaking Strength, minimum, ASTM D751: Machine direction, 500 lbf (87 b. kN/m); Cross machine direction 400 lbf (70 kN/m)
    - C. Tear Strength, minimum, ASTM D751: Machine direction, 125 lbf (22) kN/m); Cross machine direction (145 lbf (25 kN/m)
    - d. Elongation at Break, ASTM D751: 20 percent
    - e. Dynamic Impact/Puncture Resistance, ASTM D5635: Pass

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- f. Minimum Membrane Thickness, nominal, less backing, ASTM D751: 60 mils (1.5 mm)
- g. Thickness over fiber, optical method: 0.016 inches
- h. Accelerated Weathering, ASTM G155 and ASTM G154: Not greater than 5,000 hr., no cracking or crazing
- i. Abrasion Resistance, ASTM D3389: Not greater than 2,000 cycles, H-18 wheel, 1,000 g load
- j. Finished Surface Color: White
- k. Solar Reflectance Index (SRI), ASTM E1980: 110 (White, initial), 86 (White, 3-yr aged)
- B. Sheet Flashing: Manufacturer's standard smooth-backed sheet flashing of same material, type, reinforcement, thickness, and color as KEE sheet membrane.

## 2.5 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
- B. Membrane Bonding Adhesive:
  - 1. Bonding adhesive, water-based low-VOC, for bonding KEE fleece-backed single ply membranes and flashings to substrates.
    - a. Basis of design product: Tremco, Fleece Back WB Single Ply Bonding Adhesive.
    - b. VOC, maximum, ASTM D3960: 178 g/L.
- C. Flashing Membrane Adhesive:
  - 1. Bonding adhesive, solvent based fast drying, VOC-compliant, for bonding KEE smooth-backed single ply membranes and flashings to substrates.
    - a. Basis of design product: Tremco, TremPly KEE LV Bonding Adhesive
    - b. VOC, maximum, ASTM D 3960: 200 g/L
- D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 mm by 3 mm) thick; with anchors.
- E. Metal Stress Plates: Manufacturer's standard AZ50 Galvalume-coated steel formed plates, 0.047 inch thick, with radial corners and membrane-engaging barbs engineered to enhance wind resistance for mechanically-attached KEE membrane roofing systems. FMG approved.

- 1. Product: TremPly KEE Plus Stress Plates.
- F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to membrane roofing system manufacturer.
- G. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

### 2.6 VAPOR RETARDER

- A. Vapor Retarder:
  - 1. SBS-modified self-adhered vapor control membrane
    - a. Basis of design product: Tremco, AVC Vapor Barrier
    - b. Primer: AVC Membrane Primer

### 2.7 ROOF INSULATION MATERIALS

- A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from insulation manufacturer's standard sizes, suitable for application, and of thicknesses indicated. Refer to section 07 22 00 Roof and Deck Insulation for additional information.
  - 1. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated
- B. Roof Insulation: Provide roof insulation product in thicknesses indicated in Part 3 below. Minimum continuous insulation thickness shall be 1.5" at all areas.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope shown on drawings. Counter slopes developed by tapered insulation shall not be less than 1/4-inch of rise per foot of run.

## 2.8 ROOF INSULATION ACCESSORIES

- A. Cover Board:
  - 1. Glass-mat-faced gypsum panel, primed, ASTM C1177/C1177M
    - a. Basis of design product: Tremco/GP Gypsum DensDeck Prime
    - b. Thickness: 1/4 inch (6 mm)

#### 2.9 WALKPAD MATERIALS

- A. Walkway / Protection Mat Material: Flexible non-porous polyvinyl chloride (PVC) in a "duckboard" cross grid pattern.
  - 1. Manufacturers:
    - a. Watco Floors; watcofloors.com
    - b. American Floor Mats; americanfloormats.com
    - c. Or equal
- B. Walkpad mat shall be +/- 36" wide by roll form in maximum length possible. Mat color and style shall be selected from manufacturer's standard line.

## 2.10 COLORED SAFETY STRIPING

- A. Thermoplastic Ketone Ethylene Ester (KEE) Walkway material in bright yellow color.
  - a. Basis of design product: Tremco, TremPly® KEE Walkway
  - b. Walkway sheets are to be cut into 4" wide strips with all corners filleted to 3/4" radius.
  - c. Breaking Strength, minimum, 56 lbf
  - d. Dimensional Stability (%): -1.6 MD / +.63 XMD
  - d. Elongation (%): 205
  - e. Minimum Thickness: 5/32 in (4 cm)
- B. Provide continuous heat welding of safety stripe to roofing membrane at locations indicated on the Contract Drawings.

## PART 3 – EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
  - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
  - 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Concrete Roof Deck:

- a. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
- 4. Verify that existing substrate is sound and dry.
- 5. Contractor to provide three substrate adhesion tests within each area of phased work distributed across different substrate conditions within each phase. The tests shall comply with ASTM D7234 19 and be reported to the Owner, Architect, and Manufacturer prior to completion of demolition work in that area.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- D. Asphalt or tar residue must be scraped down to provide a smooth, clean substrate with no sharp edges or uneven protrusions. Manufacturer's representative will inspect the deck with the contractor prior to starting installation of the new roof system.

### 3.3 INSTALLATION, GENERAL

- A. Install roofing system in accordance with manufacturer's written instructions and approved details.
- B. Install wood cants, blocking, curbs, and nailers in accordance with requirements of section 06 10 00 Rough Carpentry.
- C. NRCA Installation Details: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations; modify as required to comply with manufacturer's approved details and perimeter fastening requirements of FM Global references if applicable.

# 3.4 VAPOR-RETARDER INSTALLATION

A. Vapor Retarder Installation, General: Completely seal vapor retarder/air barrier at terminations, obstructions, and penetrations to prevent air movement into roofing system. Seal vapor retarder/air barrier to air barrier in adjacent construction at perimeter of roofing system.

B. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

## 3.5 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Tapered Insulation and Crickets: Install tapered insulation under area of roofing to conform to slopes indicated.
  - 1. Where crickets are indicated or required to provide positive slope to drain, make slope of crickets not less than 1/4 inch in 12 inches.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - 1. Prime substrate with primer as recommended by manufacturer and allow to dry.
  - 2. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- H. Cover Boards: Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 12 inches in each direction. Loosely butt cover boards together.
  - 1. Secure cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
  - 2. Secure cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3. Adhere cover boards by setting in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining cover board in place.

## 3.6 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
- B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Water-Based Bonding Adhesive: Apply to substrate at rate required by manufacturer. Install membrane immediately into adhesive, avoiding any air entrapment; do not allow adhesive to dry. Roll membrane into wet adhesive. Do not apply adhesive to splice area of membrane.
- E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- G. Welded Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
  - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
  - 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
  - 3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- H. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

### 3.7 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hotair weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars or band clamps.

### 3.8 WALKPAD INSTALLATION

A. Flexible Walkpads: Install walkpad products in locations indicated. Walkpad sheets are designed to be laid loose over finished roofing system. At intersections with Catwalk system, at locations of slope ridges, or at changes in direction within the walkpad path, provide heat welding to substrate or adhere walkpad products to substrate with compatible adhesive according to Walkpad system manufacturer's written instructions.

### 3.9 FIELD QUALITY CONTROL

- A. Roofing Inspector: Owner will engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.10 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect, Owner, and Manufacturer.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

# END OF SECTION

## SECTION 07 56 00

## FLUID-APPLIED ROOFING

### 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. This Section includes the following:
  - 1. Roof insulation and cover board
  - 2. Base membrane sheet
  - 3. Application of fluid-applied roof membrane and flashings
- B. Related Sections:
  - 1. Section 03 30 00 Cast-in-Place Concrete
  - 2. Section 05 05 19 Post-Installed Concrete Anchors
  - 3. Section 05 40 00 Cold-Formed Metal Framing
  - 4. Section 05 50 00 Metal Fabrication
  - 5. Section 06 10 00 Rough Carpentry
  - 6. Section 07 22 00 Roof and Deck Insulation
  - 7. Section 07 54 16 Ketone Ethylene Ester Roofing
  - 8. Section 07 60 00 Flashing and Sheet Metal
  - 9. Section 07 72 00 Roof Accessories
  - 10. Section 07 92 00 Joint Sealants
  - 11. Section 07 95 00 Expansion Control
  - 12. Section 08 45 23 Fiberglass-Sandwich-Panel Assemblies
  - 13. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

### 1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 "Standard Terminology Relating to Roofing and Waterproofing" and glossary in applicable edition of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" for definition of terms related to roofing work in this Section.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  - 2. Review drawings and specifications.
  - 3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 5. Examine substrate conditions and finishes for compliance with requirements, including flatness and fastening.
  - 6. Review structural loading limitations of roof deck during and after roofing.
  - 7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
  - 8. Review governing regulations and requirements for insurance and certificates if applicable.
  - 9. Review temporary protection requirements for roofing system during and after installation.
  - 10. Review roof observation and repair procedures after roofing installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Samples for Verification: For the following products:
  - 1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
  - 2. Walkway pads or rolls.

3. Metal termination bars.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Product Certificate: Submit certificate, indicating products intended for Work of this Section, including product names and numbers and manufacturers' names, with statement indicating that products to be provided meet the requirements of the Contract Documents.
- B. Warranties: Unexecuted sample copies of special warranties.
- C. Inspection Reports: Reports of Roofing Inspector. Include weather conditions, description of work performed, tests performed, defective work observed, and corrective actions taken to correct defective work.
  - 1. Submit reports within 24 hours after inspection.

### 1.7 CLOSEOUT SUBMITTALS

- A. Executed copies of warranties
- B. Maintenance Data: To include in maintenance manuals
- 1.8 QUALITY ASSURANCE
  - A. Installer Qualifications: An employer of workers trained and certified by manufacturer, including a full-time on-site supervisor with a minimum of five years' experience installing products specified, able to communicate verbally with Contractor, Architect, and employees, and qualified by the manufacturer to install products of the full roofing system and furnish warranty of type specified.
  - B. Manufacturer Qualifications: Approved manufacturer listed in this Section, UL listed and FM Global approved for roofing systems specified for this Project, with minimum fifteen years' experience in manufacture of fluid-applied roof membrane products in successful use in similar applications. The manufacturer of this fluid-applied product shall also meet all of the qualifications of Section 07 54 16 Ketone Ethylene Ester Roofing.
    - 1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review. But in no case will a substitution be reviewed within 15 business days of the scheduled bid date:
      - a. Substitution requests must be submitted by a California licensed roofing contractor that can show prior evidence of being a manufacturer's certified installer.
      - b. Product data, including certified independent test data indicating compliance with requirements.
      - c. Physical samples of each component being substituted
      - d. Sample submittal from similar project

- e. Project references: Minimum of five installations of specified products not less than five years old, with Owner and Architect contact information. References must be for the submitting contractor using the substituted materials.
- f. Sample warranty covering the full system with all components
- g. Any product submitted for use on this project must comply with CEC 141.0(b)2Bi "Low-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75".
- 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
- C. Roofing Inspector Qualifications: A technical representative of the manufacturer who is not engaged in the sale of products and experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
  - 1. An authorized full-time technical employee of the manufacturer.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site access to manufacturer's written recommendations and instructions for installation of products.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- 1.10 PROJECT / FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
  - 1. Provide tie-offs at end of each day's work to cover exposed roofing and insulation with a course of roofing sheet securely in place with joints and edges sealed.
  - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
  - 3. Remove temporary plugs from roof drains at end of each day.
  - 4. Remove and discard temporary seals before beginning work on adjoining roofing.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Roof System Manufacturer's standard form in which Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within warranty period, as follows.
  - 1. Form of Warranty: Manufacturer's standard warranty form.
  - 2. Scope of Warranty: Work of this Section and including sheet metal details and termination details installed by the roof system Installer and approved by the Roof System Manufacturer.
    - a. Insulation materials, fasteners, and adhesives.
    - b. All new and temporary roof membrane components and adhesives.
    - c. All metal edge components including cleat strips.
    - d. All tapered edge and cant strips.
    - e. All surface mastics, coatings, stripping, plies, etc.
    - f. All drain and scupper flashing.
    - g. Any roof leak or other problems caused by substrate movement of any component other than the deck shall not be excluded.
    - h. Any movement associated with metal edge joints of flanges causing leaks.
    - i. Damages caused by wind speed up to 74 miles per hour.

- j. Permanent tie-ins and/or control joints separating new and old roofing.
- 3. One Manufacturer will provide Warranty for both single ply and specified fluid-applied roof systems.
- 4. Warranty Period: 30 years from date of completion.
- B. Manufacturer Inspection Services: By manufacturer's technical representative, to report maintenance responsibilities to Owner necessary for preservation of Owner's warranty rights. The cost of manufacturer's inspections is included in the Contract Sum.
  - 1. Inspections to occur in the following years after the Notice of completion: 2, 5, 10, 15, 20, and 25 following completion.
- C. Installer Warranty: Installer's warranty signed by Installer, as follows.
  - 1. Form of Warranty: Form acceptable to Roofing Manufacturer and Owner.
  - 2. Scope of Warranty: Work of this Section and of others as specified herein.
  - 3. Warranty Period: 2 years from date of completion.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS

- A. Basis of Design: The roof system specified in this Section is based upon products of Tremco, Inc., Beachwood, OH or pre-approved equal.
- B. Source Limitations: Obtain components for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer. Manufacturer of the membrane roofing shall be the same manufacturer of the single ply roofing identified in section 07 54 16.

## 2.2 MATERIALS, GENERAL

- A. General: Fluid-applied roofing materials recommended by roofing system manufacturer for intended use and compatible with components of existing membrane roofing system.
- 2.3 FLUID-APPLIED ROOFING MEMBRANE COATING
  - A. Polyurethane Elastomeric Fluid-Applied System: Two-coat fluid-applied roofing membrane formulated for application over prepared existing roofing substrate.
    - 1. Polyurethane roof coating system base coat, bio-based, low-odor low-VOC two-part, for use with a compatible top coat.
      - a. Basis of design product: Tremco, AlphaGuard BIO Base Coat.

- b. Combustion Characteristics, UL 790: Class A, for two-coat system.
- c. Volatile Organic Compounds (VOC), maximum, ASTM D 3960: 1 g/L.
- d. Accelerated Weathering, 5000 hours, ASTM G 154: Pass.
- e. Hardness, Shore A, minimum, ASTM D 2240: 88.
- f. Solids, by volume, ASTM D 2697: 100 percent.
- g. Bio-Based Content: Not less than 70 percent.
- 2. Polyurethane roof coating system top coat, bio-based low-odor low-VOC two-part, for application over compatible base coat.
  - a. Basis of design product: Tremco, AlphaGuard BIO Top Coat.
  - b. Combustion Characteristics, UL 790: Class A, for two-coat system.
  - c. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 6 g/L.
  - d. Solar Reflectance Index (SRI), ASTM E 1980: 103.
  - e. Accelerated Weathering, 5000 hours, ASTM G 154: Pass.
  - f. Hardness, Shore A, minimum, ASTM D 2240: 82.
  - g. Solids, by volume, ASTM D 2697: 85 percent.
  - h. Bio-Based Content: Not less than 60 percent.
- B. Fluid-Applied Roofing Reinforcing Fabric:
  - 1. Polyester Reinforcing Fabric: 100 percent stitch-bonded mildew-resistant polyester fabric intended for reinforcement of compatible fluid-applied membranes and flashings.
    - a. Basis of design product: Tremco, Permafab.
    - b. Tensile Strength, ASTM D 1682: Not less than 50 lbf. (222 N).
    - c. Elongation, ASTM D 1682: Not less than 60 percent.
    - d. Tear Strength, ASTM D 1117: Not less than 16 lbf. (70 N).
    - e. Weight: 3 oz./sq. yd (102 g/sq. m).

#### 2.4 BASE SHEET MATERIALS

- A. Base Sheet: Composite Ply HT or equal.
- B. Base Sheet Adhesive: One-part, solvent-free, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:
  - 1. Basis of design product: Tremco, SF BURmastic or equal.
  - 2. Adhesive: Asbestos Content, EPA 600 R-93/116: None.
  - 3. Volatile Organic Compounds (VOC), maximum, ASTM D 6511: 40 g/L.

## 2.5 VAPOR RETARDER

- A. Vapor Retarder:
  - 1. SBS-modified self-adhered vapor control membrane
    - a. Basis of design product: Tremco, AVC Vapor Barrier
    - b. Primer: AVC Membrane Primer

## 2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated. Refer to section 07 22 00 Roof and Deck Insulation for specific requirements.
  - 1. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated
- B. Roof Insulation: Provide roof insulation product in thicknesses indicated in Part 3 below. Minimum continuous insulation thickness shall be 1.5" at all areas.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope shown on drawings. Counter slopes developed by tapered insulation shall not be less than 1/4-inch of rise per foot of run.

## 2.7 ROOF INSULATION ACCESSORIES

- A. Cover Board:
  - 1. Glass-mat-faced gypsum panel, primed, ASTM C1177/C1177M
    - a. Basis of design product: Tremco/GP Gypsum DensDeck Prime
    - b. Thickness: 1/4 inch (6 mm)

### 2.8 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with existing roofing system and fluid-applied roofing system.
- B. Asphaltic Surfaces Primer: Single-component, multi-substrate primer to promote adhesion of base coat to surfaces recommended by manufacturer.
  - 1. Basis of Design Product: AlphaGuard WB Primer or equal.
- C. Slip-Resistant Top Coat Aggregate: Silica sand, 20 40 mesh.

## 2.9 WALKPAD MATERIALS

- A. Walkway / Protection Mat Material: Flexible non-porous polyvinyl chloride (PVC) in a "duckboard" cross grid pattern.
  - 1. Manufacturers:
    - a. Watco Floors; watcofloors.com
    - b. American Floor Mats; americanfloormats.com
    - c. Or equal
- B. Walkpad mat shall be +/- 36" wide by roll form in maximum length possible. Mat color and style shall be selected from manufacturer's standard line.
- 2.10 COLORED SAFETY STRIPING
  - A. Provided color tinted top coat material and Slip Resistant aggregate in a 4" wide stripe over membrane top coat. Color shall equal a bright yellow.

## PART 3 – EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
  - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
  - 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Concrete Roof Deck:
    - a. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  - 4. Verify that existing substrate is sound and dry.

- 5. Contractor to provide three substrate adhesion tests within each area of phased work distributed across different substrate conditions within each phase. The tests shall comply with ASTM D7234 19 and be reported to the Owner, Architect, and Manufacturer prior to completion of demolition work in that area.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSULATION INSTALLATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- D. Asphalt or tar residue must be scraped down to provide a smooth, clean substrate with no sharp edges or uneven protrusions. Manufacturer's representative will inspect the deck with the contractor prior to starting installation of the new roof system.

## 3.3 INSTALLATION, GENERAL

- A. Install roofing system in accordance with manufacturer's written instructions and approved details.
- B. Install wood cants, blocking, curbs, and nailers in accordance with requirements of section 06 10 00 Rough Carpentry.
- C. NRCA Installation Details: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations; modify as required to comply with manufacturer's approved details and perimeter fastening requirements of FM Global references if applicable.

## 3.4 VAPOR-RETARDER INSTALLATION

- A. Vapor Retarder Installation, General: Completely seal vapor retarder/air barrier at terminations, obstructions, and penetrations to prevent air movement into roofing system. Seal vapor retarder/air barrier to air barrier in adjacent construction at perimeter of roofing system.
- B. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

## 3.5 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Tapered Insulation and Crickets: Install tapered insulation under area of roofing to conform to slopes indicated.
  - 1. Where crickets are indicated or required to provide positive slope to drain, make slope of crickets not less than 1/4 inch in 12 inches.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - 1. Prime substrate with primer as recommended by manufacturer and allow to dry.
  - 2. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- H. Cover Boards: Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 12 inches in each direction. Loosely butt cover boards together.
  - 1. Secure cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
  - 2. Secure cover boards to resist uplift pressure at corners, perimeter, and field of roof.
  - 3. Adhere cover boards by setting in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining cover board in place.

- A. Install base sheet starting at low point of roofing. Align base sheet without stretching. Shingle side laps of base a minimum of 4 inches. Shingle in direction to shed water. Extend base sheets over edges and terminate above cants.
  - 1. Embed base sheet in cold-applied membrane adhesive applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
- B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing and 6 inches onto field of roofing.
- C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
  - 1. Seal top termination of base flashing with a metal termination bar.
- D. Install stripping according to roofing manufacturer's written instructions where metal flanges and edgings are set on roofing.
  - 1. Flashing Sheet Stripping: Install flashing sheet stripping in specified cold adhesive and extend onto roofing membrane.
- E. Roof Drains: Install base sheet in cold adhesive around drain bowl. Base sheet must be installed so that it will be under compression from the clamping ring. Install base coat, fiberglass reinforcement, and top coat over base sheet. Install drain clamping ring and strainer.

## 3.7 FLUID-APPLIED MEMBRANE APPLICATION

- A. Base Coat: Apply base coat in accordance with manufacturer's written instructions. Back roll to achieve minimum wet mil coating thickness of 48 mils unless otherwise recommended by manufacturer; verify thickness of base coat as work progresses.
  - 1. Apply base coat on prepared and primed surfaces and spread coating evenly.
  - 2. Embed polyester reinforcement into wet base coat. Lap adjacent flashing pieces of polyester minimum 3 inches along edges and 6 inches at end laps.
  - 3. Roll surface of polyester reinforcing to completely embed and saturate fabric. Leave finished base coat with fabric free of pin holes, voids, or openings.
  - 4. Allow base coat to cure prior to application of top coat.
- B. Top Coat: Apply top coat uniformly in a complete installation to field of roof and flashings.
  - 1. Prime base coat prior to application of top coat if top coat is not applied within 72 hours of the base coat application, using manufacturer's recommended primer.
- 2. Apply top coat to flashings extending coating up vertical surfaces and out onto horizontal surfaces 4 inches. Install top coat over field base coat and spread coating evenly.
- 3. Back roll to achieve wet mil thickness of 32 mils unless otherwise recommended by manufacturer.
- 4. Avoid foot traffic on new fluid-applied membrane for a minimum of 24 hours.
- C. Fluid-Applied Flashing Application: Complete base coat and polyester reinforcement at parapets, curbs, penetrations, and drains prior to application of field of fluid-applied membrane.
  - 1. Extend coating minimum of 8 inches up vertical surfaces and 4 inches onto horizontal surfaces.
  - 2. Roof Drains: Install base coat onto surrounding membrane surface and metal drain bowl flange. Install target piece of polyester reinforcement immediately into wet base coat and roll to fully embed and saturate fabric. Reinstall clamping ring and strainer following application of top coat. Replace broken drain ring clamping bolts.
- D. Slip-Resistant Walkway Topcoat: Apply walkway second topcoat following application and curing of top coat. Locate as indicated, or as directed by Owner.
  - 1. Mask walkway location with tape.
  - 2. Prime first top coat prior to application of walkway top coat if walkway top coat is not applied within 72 hours of the first top coat application, using manufacturer's recommended primer.
  - 3. Back roll to achieve wet mil thickness of 20 mils unless otherwise recommended by manufacturer.
  - 4. Broadcast 20 to 30 lbs. per 100 sq. ft. of Slip-Resistant Top Coat Aggregate in wet top coat.
  - 5. Back roll sand and top coat creating even dispersal of sand. Remove masking immediately.

# 3.8 WALKPAD INSTALLATION

A. Flexible Walkpads: Install walkpad products in locations indicated. Walkpad sheets are designed to be laid loose over finished roofing system. At intersections with Catwalk system, at locations of slope ridges, or at changes in direction within the walkpad path, provide heat welding to substrate or adhere walkpad products to substrate with compatible adhesive according to Walkpad system manufacturer's written instructions.

### 3.9 FIELD QUALITY CONTROL

- A. Roof Inspection: Contractor shall engage roofing system manufacturer's technical personnel to inspect roofing installation, and submit report to the Architect. Notify Architect and Owner 48 hours in advance of dates and times of inspections. Inspect work as follows:
  - 1. Upon completion of preparation of first component of work, prior to application of re-coating materials.
  - 2. Following application of re-coating to flashings and application of base coat to field of roof.
  - 3. Upon completion of re-coating but prior to re-installation of other roofing components.
- B. Repair fluid-applied membrane where test inspections indicate that they do not comply with specified requirements.
- C. Arrange for additional inspections, at Contractor's expense, to verify compliance of re-placed or additional work with specified requirements.

# 3.10 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect, Owner, and Manufacturer.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

# SECTION 07 60 00

# FLASHING AND SHEET METAL

# PART 1 – GENERAL

## 1.1 DESCRIPTION

- A. Related Documents: Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Sections apply to Work of this Section as if printed herein.
- B. Section Includes: Description of requirements for materials, fabrications, and installation of flashing and sheet metal work, except that which is shown or specified to be provided elsewhere. Only major items are shown or noted. Work and/or items include, but are not necessarily limited to, the following:
  - 1. Roof flashings with galvanized finish
  - 2. Counter flashing over Roofing base flashings with galvanized finish
  - 3. Counter flashing to lap under existing roof mounted mechanical equipment, exhaust fans, vent stacks, etc.
  - 4. Parapet caps
- C. RELATED SECTIONS
  - 1. Section 05 05 19 Post-Installed Concrete Anchors
  - 2. Section 05 40 00 Cold-Formed Metal Framing
  - 3. Section 06 10 00 Rough Framing
  - 4. Section 07 54 16 Ketone Ethylene Ester Roofing
  - 5. Section 07 56 00 Fluid-Applied Roofing
  - 6. Section 07 92 00 Joint Sealants
  - 7. Section 09 91 00 Painting

# 1.2 REFERENCES

- A. ANSI/ASTM B32 Solder Metal
- B. ASTM A167 Stainless and Heat Resisting Chromium Nickel Steel Plate
- C. ASTM A525 Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process
- D. ASTM 832 Solder Metal
- E. FS 0 F 506 Flux, Soldering, Paste and Liquid

- F. FS SS C 153 Cements Bituminous, Plastic
- G. SMACNA Architectural Sheet Metal Manual of the Sheet Metal and Air Conditioning Contractors National Association, Inc., Latest Edition with all Bulletins
- 1.3 QUALITY CONTROL
  - A. References and Standards (Latest Edition unless otherwise noted):
    - 1. American Society for Testing and Materials (ASTM)
    - 2. American Welding Society, "Standard Welding Code (AWS); Sheet Steel D1.3
    - 3. Federal Standards (FS)
    - 4. Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA); "Architectural Sheet Metal Standard", Seventh Edition
- 1.4 SUBMITTALS (Submit under the provisions of Section 01 33 23)
  - A. Product Data: For manufactured items and proposed substitutions: Submit specific plates from SMACNA manual consistent with and acceptable to documentation intended installation.
  - B. Describe material profile, jointing pattern, jointing details, fastening methods, and installation details. All work to meet or exceed SMACNA standards or as detailed whichever is more restrictive.
  - C. Shop drawings per Section 01 33 23.
- 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
  - A. Deliver, store, and handle packaged materials in original containers with seals unbroken and labels intact until time of use.
  - B. Discharge materials carefully and store on clean concrete surface or raised platform in safe, dry area. Do not dump onto ground.
  - C. Stack preformed materials to prevent twisting, bending, and abrasion and to provide ventilation.
- 1.6 JOB CONDITIONS
  - A. Protection:
    - 1. At all times against damage or contamination during the Work. Do not use damaged or distorted items in the Work.
    - 2. Exercise care when working on or about roof surfaces to avoid damaging or puncturing roofing membrane.

- 3. Protect exposed finishes as required against construction damage; remove prior to final inspection.
- B. Scheduling and Sequencing: Insure timely delivery of items to be embedded in work of other sections and furnish setting instructions for exact installation.
- C. Work under this section is to physically protect roofing and exterior from damage that would allow water leakage into the building interiors.

# 1.7 QUALITY ASSURANCE

A. Applicator: Company specializing in sheet metal flashing work with a minimum of 10 years of experience.

# 1.8 WARRANTY

A. Warranty period for this Work is extended to two (2) years against all defects in materials, workmanship and leaks. Warranty shall cover damage from leaks due to defective materials or workmanship. Warranty coverage shall be at 100% of all cost of defects and repairs to be borne by the contractor.

# PART 2 – PRODUCTS

# 2.1 MATERIALS

- A. Sheet Metals:
  - 1. Galvanized Sheet Metal: ASTM A653, G 90, commercial quality, heavy duty 20 gauge, unless otherwise noted. Use hot-dip galvanized steel or cadmium plated fasteners.
  - 2. Steel plates and flat bar stock shall have galvanized finish and conform to ASTM A36.
  - 3. Pre-finished sheet metal flashing with Kynar 500 coating.
- B. Solder and Flux: Types as recommended by manufacturer of sheet metal to be soldered. Re-melted or re-worked solder will not be permitted. Solder: ANSI/ ASTM B32, Class AI. Flux: FS-0-F-506.
- C. Asphaltic Primer: ASTM D41.
- D. Plastic Cement: Asphaltic, FS SS-C-153, Type I, asphaltic base cement.
- E. Sealants:
  - 1. Refer to Section 07 92 00 Joint Sealants
- F. Packing and Wedges: Lead or other nonferrous alloys as approved by Architect.
- G. Items for Permanent Protection of Dissimilar Metals and Materials:
  - 1. Sheet Membrane Waterproofing

- 2. Bituminous Paint: FS TT-C-494A
- 3. Compressible Tape: ASTM C509 Closed cell black neoprene tape, size as noted, with adhesive system as recommended by manufacturer.
- H. Protective backing paint: FS-TT-C-494A, Bituminous paint

# 2.2 FABRICATION

- A. General Requirements:
  - 1. Items of standard manufacture may be furnished in lieu of specially fabricated items provided such items meet requirements shown or noted.
  - 2. As far as practicable, form and fabricate sheet metal items true to shape, accurate in size, and square in shop. Where circumstances require on-site fabrication, provide quality equal to shop work.
  - 3. Reproduce accurately to profiles and bends as shown or noted. Ensure that intersections are sharp, even, and true; that plane surfaces are free from buckles and waves; that seams follow direction of water flow.
  - 4. Where work is not otherwise shown or noted, design and fabricate in accordance with SMACNA.
  - 5. Reinforce properly as required for strength and appearance in longest practical lengths.
  - 6. Cut, fit, and drill sheet metal as required to accommodate accessory items and work adjacent or adjoining.
  - 7. Exposed Edges of Sheet Metal: Fold, bead, Hem or return; no raw edges will be permitted. Miter and seam all corners and expansion joints.
  - 8. Fabricate cleats and starter strips of same material as sheet metal gutters and cleats to be interlocking with sheet metal gutter.
- B. Sheet Metal Joints:
  - 1. In general, provide lock joints; where impractical, lap, rivet, and solder.
  - 2. Turn lock joints on exposed surfaces in direction of flow.
  - 3. Miters joints and solder.
  - 4. Where positive joining is required, arc-weld in accordance with AWS D1.1, or braze.
  - 5. Expansion joints shall provide soldered end cap at each gutter with sheet metal cap over expansion gap.
- C. Soldering:
  - 1. Pre-tin edges 1 1/2 inches both sides prior to soldering.

FLASHING AND SHEET METAL

- 2. Use heavy soldering coppers of blunt design (except for zinc alloy sheet metal, use medium irons).
- 3. Immediately after applying flux, solder slowly with well-heated coppers, thoroughly heating seams and completely sweating solder through full width with at least one inch width along seams.
- 4. After soldering, immediately neutralize any acid flux and flush with clean water.
- 5. Do not solder aluminum
- D. Expansion-Contraction of Sheet Metal Runs: Provide loose locking slip joint at maximum of ten (10) feet, unless SMACNA recommends more frequent intervals. Flood gutter for 24 hours to verify all expansion joints are 100 percent water tight.
- E. Flashing and Counterflashing:
  - 1. Fabricate runs in maximum lengths subject to expansion/contraction allowance with minimum number of joints.
  - 2. Form counterflashings to lock rigidly into reglets where required.
  - 3. Exposed Edges: Turn back and hem 1/2 inch.

### 2.3 FINISHES

- A. Sheet Metal: Manufacturer's standard finish unless otherwise noted herein.
  - 1. Sheet Metal: Field paint all surfaces of sheet metal not receiving elastomeric coating identified below.
    - a. Painting shall be in accordance with Section 09 91 00 Painting.
  - 2. All surfaces of gutters, downspouts, flashings, etc. shall be factory galvanized or field toughed up.
  - 3. Coated metal: Refer to Section 07 54 16 Ketone Ethylene Ester Roofing for factory coated metal flashing to be used at all roofing system details.
- B. Permanent Protection of Dissimilar Metals and Materials:
  - 1. Items in Contact with Dissimilar Metals: Protect as required to prevent corrosion and discoloration from galvanic action.
  - 2. Items in Contact with Concrete, Masonry Mortar, or No Accessible Alter Installation: Underlay items with asphalt-saturated felt or apply heavy coating of bituminous paint at areas of contact.
  - 3. Items in Contact with Moisture Absorbent Materials or Preservative-Treated Wood: Apply heavy coating or bituminous paint to such items.

- 4. Fasteners and Anchors of Materials Dissimilar from Item Fastened: Mask as required to prevent corrosion and discoloration from galvanic action.
- 5. Contractor to verify with painting contractor that the primer is compatible with finish coats of paint at exposed flashings, caps, etc. to be finished painted.
- C. Interior coating of gutters:
  - 1. After gutters are installed and before flood testing, contractor shall coat interior of gutter with elastomeric roofing coating per Section 07 54 00 Thermoplastic Membrane Roofing.

# PART 3 – EXECUTION

# 3.1 INSPECTION

- A. Examine areas to receive items and verify the following:
  - 1. All shapes and dimensions of surface to be covered.
  - 2. That substrates, adjacent or adjoining surfaces are clean, dry and reasonably smooth, and free from defects to extend needed for sheet metal work.
  - 3. That wood surfaces to be in contact with sheet metal are free from projecting nails.
  - 4. Absence of other conditions that will adversely affect installation.
- B. Do not start work until unsatisfactory conditions have been corrected. Beginning of work means acceptance of existing conditions.

### 3.2 PREPARATION

- A. Coordinate as required with installation of related work.
- B. Field measure site conditions prior to fabricating work.
- C. Install starter edge strips and cleats prior to starting.
- D. Install reglets true to lines and plumb or levels. Seal top of reglets with sealant.
- E. Insert flashing into reglets to form tight fit. Secure in place with plastic wedges at maximum 12 inches on center. Seal flashings into reglets with sealant.
- F. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations approved by Architect.
- G. Lock and seal all joints.
- H. Apply plastic cement compound between metal flashings and felt flashings.

- I. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- J. Solder metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.
- K. Seal metal joints watertight.

## 3.3 INSTALLATION

- A. General Requirements:
  - 1. Install items in accordance with SMACNA unless otherwise indicated.
  - 2. Standard Catalog Products: Install in strict accordance with approved manufacturer's instructions unless otherwise indicated.
  - 3. Where installation requires performing work of fabrication, meet requirements of applicable standards of Fabrication Article.
  - 4. Apply flashing compound at slip joints or wherever else metal to metal contact occurs and movement may be anticipated.
  - 5. Sheet metal installed in conjunction with roofing shall be installed in accordance with the roofing manufacturer's recommendation and requirements or specification whichever is more restrictive.
  - 6. Insure that items are installed in true and accurate alignment with other items and related work; that joints are accurately fitted; that exposed surfaces are free from dents; that corners are reinforced; that seams are watertight.
  - 7. All work shall be left free of oil, grease, or acid and ready to receive painter's finish.
  - 8. Wherever possible, all fasteners shall be concealed. All exposed fasteners shall have neoprene gaskets and capped with a bead of sealant.
- B. Flashing and Counterflashing:
  - 1. Install in reglets to form tight fit. Secure in place with lead wedges. Seal flashings into reglets with sealant.
  - 2. Apply a continuous bead of sealant (compatible with membrane roofing material) along the bottom edge of flashings (or counterflashings).
- C. Miscellaneous Items: Fabricate and install all other miscellaneous sheet metal, flashings, counterflashings, reglets, etc. as detailed, indicated or required to complete the work. Furnish and install all other miscellaneous ferrous and nonferrous sheet metal items as indicated, except where such items are specified to be included under other Sections of the Specifications. Finish shall match similar items or adjacent surfaces.

# 3.4 SEALANTS

- A. Surface of joints and spaces to be sealed shall be dry and free from dust, dirt, and foreign matter. All oils and films of any nature shall be removed.
  - 1. Prepare surfaces to which the sealants are to bond to by priming with primer or surface conditioner manufactured in any joint or on any surface that has not been cleaned and primed or conditioned.
  - 2. Provide backup or filler material to all joints or spaces having a depth greater than 3/8 inch.
  - 3. Apply sealants in accordance with the manufacturer's instructions and applicable portions of Section 07 92 00. Sealants shall be applied to both sides of all joints or space unless indicated otherwise. Remove excess sealant and leave surfaces neat and clean and with a uniform smooth finish on the sealant.

### 3.05 TOUCH-UP

A. Where finish is damaged by fabrication or installation, repair galvanized, prefinished and prime painted surfaces with specified touch-up material, applying in accordance with manufacturer's printed directions. Float galvanized material full, grind, and buff smooth.

## END OF SECTION

# SECTION 07 72 00

# ROOF ACCESSORIES

## PART 1 – GENERAL

### 1.1 SECTION INCLUDES

A. The work covered by this specification consists of furnishing all labor, equipment, materials, accessories, and performing all operations required for the correct installation of recycled rubber and strut supports for mechanical piping, electrical conduit, and general rooftop supports.

### 1.2 RELATED SECTIONS

- A. Section 05 50 00 Metal Fabrication
- B. Section 05 53 00 Metal Grating
- C. Section 07 54 16 Ketone Ethylene Ester Roofing
- D. Section 07 56 00 Fluid-Applied Roofing
- E. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

### REFERENCES

- A. ASTM A653 G90 SS Gr. 33 Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dipped Process
- B. ASTM B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- C. ASTM C531 Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, Monolithic Surfaces, and Polymer Concretes
- D. ASTM C642 Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete
- E. ASTM C672 Test Methods for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
- F. ASTM D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
- G. ASTM D395 Standard Test Methods for Rubber Property Compression Set
- H. ASTM D573 Test Method for Rubber Deterioration in an Air Oven
- I. ASTM D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

- J. ASTM D2240 Test Method for Rubber Property Durometer Hardness
- K. NFPA 70 National Electrical Code

## 1.3 QUALITY ASSURANCE

- A. Rubber / steel pipe and conduit supports shall be manufactured under a strict quality control program assuring quality product delivered to the jobsite. Pipe supports that are damaged shall not be installed.
- B. Workmanship: All pipe and conduit supports to be installed by a qualified contractor and installed in accordance with manufacturer's recommendations.
  - 1. All work shall comply with all applicable federal, state, and local codes and laws having jurisdiction.
  - 2. All work shall conform to accepted industry and trade standards for pipe and conduit support installations.
- C. The installation of the rubber / steel supports blocks shall also comply with the requirements of the roofing system manufacturer. See section 07 54 16 Ketone Ethylene Ester Roofing.

### PART 2 – PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with these specifications, pipe support systems shall be:
  - 1. "Dura-Blok" design as supplied by Cooper B-Line, Inc.
  - 2. "C" and "CW" Series design as supplied by C-Port of Clearline Technologies
  - 3. Pre-approved equal as reviewed by the Architect and University per section 01 25 00 Substitution Procedures.

## 2.2 MATERIALS

- A. Curb base must be made of 100% recycled rubber and polyurethane prepolymer with a uniform load capacity of a minimum of 500 pounds per linear foot of support. In addition, each base shall have a reflective stripe.
- B. Minimum Dimensions: 6-inches wide by 4 inches tall by 9.6 inches long or 12 inches wide by 2 5/8 inches tall by 12 inches long for the rubber block itself.
- C. Steel frame: Steel, 14ga strut galvanized per ASTM A653 or 12ga strut galvanized per ASTM A653 for bridge series. Strut height to be selected from standard strut models as required for the elevation of the pipe / conduit required.
- D. Attaching hardware: Zinc-plated threaded rod, nuts, and attaching hardware per ASTM B633.

- E. Any products claiming to be a similar, like, or equal must demonstrate (meet or exceed) the same physical and performance characteristics as specified below:
  - 1. Density: 0.52 oz/cu in per ASTM C642
  - 2. Durometer Hardness: 67.2A ± 1 per ASTM D2240
  - 3. Tensile Strength: 231 psi minimum per ASTM D412
  - 4. Compression Deformation: 5% at 70psi and 72°F per ASTM D395
  - 5. Brittleness at Low Temp: -50°F per ASTM D746
  - 6. Freeze and thaw when exposed to deicing chemicals: No loss after 50 cycles per ASTM C672
  - Coefficient of Thermal Expansion: 8 x 10 6 in/in/°F (min) per ASTM C531
  - 8. Weathering: 70 hours at 120°F per ASTM D573
    - a. Hardness retained: 100% (±5%)
    - b. Compressive strength: 100% (±5%)
    - c. Tensile strength: 100% (±5%)
    - d. Elongation retained: 100% (±5%)

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. If gravel top roof, gravel must be removed around and under pipe support.
- C. Always consult roofing manufacturer for roof membrane compression capacities. If necessary, a compatible sheet of roofing material (rubber pad) may be installed under rooftop support to disperse concentrated loads and add further membrane protection.
- D. Support blocks are not to be affixed or anchored to the roof membrane or structure. Allow supports to float on membrane.
- E. Gas pipe spacing subject to local gas authorities.
- F. Use properly sized clamps to suit pipe or conduit sizes.

END OF SECTION

# SECTION 07 92 00

### JOINT SEALANTS

### PART 1 – GENERAL

#### 1.1 DESCRIPTION

- A. Related Documents: Drawings and General Provisions of Contract, including General Conditions and Division 01 Specification Sections apply to Work of this Section as if printed herein.
- B. Section Includes: Description of requirements for materials, fabrications, and installation of sealants, caulking, and associated accessories, except for those specified in other Sections, where indicated on Drawings, and where required to provide for a weather tight and watertight condition shall be furnished and installed under this section of the specifications.
- C. Related Sections:
  - 1. Section 05 50 00 Metal Fabrication
  - 2. Section 07 60 00 Flashing and Sheet Metal
  - 3. Section 09 91 00 Painting
  - 4. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

## 1.2 QUALITY ASSURANCE

- A. Referenced and Standards:
  - 1. American Society for Testing and Materials (ASTM)
  - 2. Federal Specifications
- B. Acceptable Manufacturers: Dow Corning; General Electric; Tremco; Vulkem; or 3M or equal.
- C. Applicator's Qualifications: Application of sealants shall be by firm regularly engaged in this type of work and approved by the manufacturer, employing skilled mechanics who are skilled in the application of sealants and caulking herein specified.
- D. Job Mock-up: Prepare sample application in locations directed by Architect. The mock-up shall constitute a standard of acceptance for the Work.
- E. Compatibility: Contractor to verify that all sealants and caulking are compatible with adjacent finishes.

- 1.3 SUBMITTALS (Submit per section 01 33 23)
  - A. Manufacturer's Data: Submit list of materials proposed for use including complete data including color charts and manufacturer's specifications and installation instructions for each type of sealant, caulking compound, and associated miscellaneous material required. Include published data, letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the application shown. Include location of each material.
  - B. Samples: Submit standard color ranges of exposed materials for Architect's selection.
- 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING
  - A. Materials shall be delivered to job in sealed containers with manufacturer's name, labels, project identification, and lot numbers where appropriate.
  - B. Store material out of weather in original containers or unopened packages as recommended by manufacturer.
- 1.5 JOB AND ENVIRONMENTAL CONDITIONS
  - A. Job Conditions: The Sealant and Caulking Contractor shall acquaint himself with all conditions relating to the work of this Section.
  - B. Environmental Conditions: Do not proceed with installation of sealants under adverse weather conditions or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of High Early Bond strength.
- 1.6 WARRANTY
  - A. Warranty period for this work is extended to ten (10) years for materials; and workmanship against leakage for two (2) years.

# PART 2 – PRODUCTS

- 2.1 MATERIALS
  - A. Sealants: Sealants shall be polysulfide, polyurethane, or silicone elastomeric type sealants all conforming to the following specifications.
    - Single-component sealants shall conform to FS TT-S-00230C, Class A, Type II, and/or ASTM C920-79, Type S, Grade NS, Class 25. Polyurethane, non-sag, medium modules joint sealant.
    - 2. Multi-component sealants shall conform to FS TT-S-00227E, Class A, Type I (self-leveling) or Type II, and/or ASTM C920-79, Type M, Grade P or NS, Class 25.
    - 3. One-part silicone sealant that meets FS TT-S-001543, Class A, and/or ASTM C920-75, Type S, Grade NS, Class 50.

- a. Do not use silicone sealant in seismic joints or horizontal joints in sidewalks, terraces, decks, concrete and tile floors, and driveways.
- 4. No-Pick sealant at locations indicated on Drawings:
  - a. High solids, two component epoxy resin; ASTM C881, Type 1, Grade 3, Classes B and C.
  - b. Compressive Strength: 10,000 psi in 7 days when tested in accordance with ASTM D695 at 75 degrees F and 50 percent relative humidity. Material shall attain 75 percent ultimate strength within 16 hours.
- 5. Synthetic rubber sealant tape consisting of thread-reinforced butyl tape in roll form. A material thickness of 1/16" to 1/8" and in various widths from 3/8" to 2".
  - a. Material used to form a watertight gasket-like seal in applications such as bedding glass, around window and door frames, seating equipment on curbs, etc. They can also act as a metal seam sealer in overlap seams, building panels, rain gutters, and can be used in conjunction with mechanical fasteners.
    - 1) 3M Weatherban Ribbon Sealant PF5422 or PF5423 or equal.
    - 2) Tremco TremFlash (TF) Tape
- 6. All exposed sealant material shall be of a color acceptable to Architect or shall be a paintable type where directed.
- 7. All sealants shall conform with volatile organic compound (VOC) requirement of the State of California and the local authority having jurisdiction. Where sealants do not meet these requirements, their use shall be limited to exterior use only and their installation shall be scheduled with sufficient time to allow for full curing before occupancy.
- B. Primer: As recommended by the sealant manufacturer. Primer will be required for all surfaces to receive sealants.
- C. Backup Materials: Non-staining, compatible with sealant and primer, and of a resilient nature such as closed cell resilient foam, sponge rubber, polyvinyl chloride tubing or glass mat. Materials impregnated with oil, bitumen or similar materials shall not be used. Sealants shall adhere to backup material.
- D. Bond Breaker: Polyethylene tape or masking tape as recommended by the sealant manufacturer.
- E. Solvents and Cleaning Agents: Accessory materials shall be as recommended by the sealant manufacturer.

- F. Caulking: Where specifically called for on the Drawings, shall be "Plastoid" Type C, Pabco "White Hydroseal", or approved equal conforming to Fed.Spec. TT-C-00598C.
- G. Color of sealant shall match adjacent surface to which it is applied or shall be as selected by the Architect. Use non-sag type sealant on vertical surfaces.

# PART 3 – EXECUTION

# 3.1 INSPECTION

- A. Surface Acceptance: Examine all surfaces to be sealed or caulked for acceptance.
  - 1. Joint dimensions shall be inspected and reviewed to verify that they are in conformance with specifications and manufacturer's requirements and are acceptable to receive sealant and backup materials.
  - 2. Joints shall be of sufficient width and depth to accommodate specified backer material or preformed joint filler and sealants, but in no case shall sealant application be less than 1/4" wide and 1/4" deep, except as recommended by the manufacturer or otherwise approved by the Architect.
- B. Do Not seal or caulk joints until they are in compliance with requirements of the approved manufacturer of materials, the details as shown on the drawings and the specified requirements of other sections of the specifications.

# 3.2 PREPARATION

- A. General: Thoroughly clean all joints, removing all foreign matter such as dust, oil, grease, water, surface dirt, etc. Sealant must be applied to the base surface.
- B. Porous Material such as concrete or masonry shall be cleaned where necessary by grinding, sand, or water blast cleaning, mechanical abrading, acid washing, or a combination of these methods as required to provide a clean, sound base surface for sealant adhesion.
  - 1. Laitance shall be removed by acid washing, grinding, or mechanical abrading.
  - 2. Form oils, release agents, or chemical retardants shall be removed by sand or water blast cleaning.
  - 3. Loose particle present or resulting from grinding, abrading or blast cleaning shall be removed by blowing out joints with compressed air (oil-free) prior to application of primer or sealant.
  - 4. Sealants shall not be applied to masonry joints where water repellent or masonry preservative has been applied. Waterproofing treatments shall be applied after sealants and caulking when called for.
- C. Nonporous Surfaces such as metal and glass shall be cleaned either mechanically or chemically. Protective coatings on metallic surfaces shall be

removed by a solvent that leaves no residue. Solvent shall be used with clean white cloths or lint free paper towels and wiped dry with clean, dry white cloths or lint free paper towels. Do not allow solvent to air dry without wiping. Joint areas protected with masking tape or strippable films shall be cleaned as above after removal of tape or film.

D. Sealant Preparation: Do not modify the sealant by addition of liquids, solvents or powders. Mix multi-component elastomeric sealants in accordance with manufacturer's printed instructions.

# 3.3 APPLICATION:

- A. Back Up: Install backup material or joint filler of type and size specified at proper depth in joint to provide sealant dimensions as detailed or as recommended by the manufacturer. Backup material shall be of suitable size and shape so that when compressed (25 to 50 percent), it will fit in joints as required. Sealant shall not be applied without backup material and, if necessary, bond breaker strip. When using backup of hose or rid stock, roll the material into the joint to avoid lengthwise stretching. Hose or rod stock shall not be twisted or braided.
- B. Bond Breaker: Use specified bond breaker strip between sealant and supporting type backup material. Bond breaker strip shall be used in all joints where sufficient room for backup does not exist or where required to prevent sealant bonding to undesirable surfaces.
- C. Apply Masking Tape: Where required, in continuous strips in alignment with joint edge. Remove tape immediately after joints have been sealed and tooled as directed.
- D. Prime surfaces to receive joint sealant with primer as recommended by sealant manufacturer. Do not apply primer to exposed finish surfaces.
- E. Sealant: Do not use a sealant compound that has exceeded its shelf life or has become too jelled to be discharged in a continuous flow from the gun.
  - 1. Apply sealant with a caulking gun, using proper nozzles. Use sufficient pressure to properly fill the joints with sealant to the back-up material.
  - 2. After joints have been completely filled, they shall be neatly tooled to eliminate air pockets or voids and to provide a smooth, neat appearing finish in intimate contact with interfaces. After tooling, surface at sealant shall be free of ridges, wrinkles, sags, air pockets and embedded impurities. When tooling white or light colored sealants, use clean water, wet or dry tool or tooling solution recommended by sealant manufacturer.

### 3.4 CLEAN-UP

A. Immediately clean adjacent surfaces free of sealant or soiling resulting from this work as work progresses. Use a solvent or cleaning agent as recommended by the sealant manufacturer. All finished work shall be left in a neat, clean condition.

- B. Remove masking tape immediately after tooling joints, leaving finished work in a neat and clean condition.
- C. Upon completion of the work of this section, remove all resulting surplus materials, rubbish and debris from the premises.

# END OF SECTION

# SECTION 07 95 00

# EXPANSION CONTROL

## PART 1 – GENERAL

### 1.1 DESCRIPTION

- A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section Includes: Architectural joint systems for building exteriors creating a weather tight closure between roofs, curbs, and walls.
- C. Related Sections:
  - 1. Section 05 40 00 Cold-Formed Metal Framing
  - 2. Section 06 10 00 Rough Carpentry
  - 3. Section 07 54 16 Ketone Ethylene Ester Roofing
  - 4. Section 07 56 00 Fluid-Applied Roofing
  - 5. Section 07 60 00 Flashing and Sheet Metal
  - 6. Section 07 92 00 Joist Sealants

### 1.2 QUALITY ASSURANCE

- A. Referenced and Standards:
  - 1. American Society for Testing and Materials (ASTM)
- B. Manufacturer: Obtain joint cover assemblies including accessories through one source from a single manufacturer.
  - 1. Manufacturer shall have a third party certified ISO 9001 quality management system.
    - a. The manufacturer shall have documented management and control of the processes that influence the quality of its products.
    - b. The manufacturer shall have documented management and control of the processes that influence the quality of its customer service.
  - 2. Manufacturer shall have a minimum of ten (10) years of experience in the fabrication of joint cover assemblies.
- C. Installer: All products listed in this section shall be installed by a single installer with demonstrated experience in installing products of the same type and scope

as specified. Installer shall be insured and licensed as required by agencies within the project's jurisdiction.

D. Fire-Test-Response Characteristics: Where indicated, provide architectural joint system and fire-barrier assemblies identical to those of assemblies tested for fire resistance per UL 2079 and/or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction. Fire rating not less than the rating of adjacent construction.

# 1.3 DEFINITIONS

- A. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
- B. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
- C. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint.
- D. Nominal Joint Width: The width of the linear opening specified in practice and in certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the application shown. Include location of each material.

# 1.4 SUBMITTALS

- A. Comply with Division 01 requirements.
- B. Product Data: Manufacturer's specifications and technical data edited specifically for proposed system, including specific requirements indicated.
  - 1. Detailed specification of construction and fabrication.
- C. Shop Drawings: Indicate joint device profile, dimensions, location in the work, affected adjacent construction, anchorage devices, and location of splices.
- D. Samples: Submit 2 6-inch samples, illustrating operational properties of assemblies.
- E. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions. Include anchorage requirements.

# 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to job in sealed containers with manufacturer's name, labels, project identification, and lot numbers where appropriate.
- B. Store material out of weather in original containers or unopened packages as recommended by manufacturer.

### 1.6 WARRANTY

A. Provide manufacturer's written 5 year warranty for all joint covers.

- B. Warrant materials and fabrication against defects after completion and final acceptance of Work.
  - 1. Repair defects, or replace with new materials, faulty materials or fabrication developed during the warranty period at no expense to Owner.

# PART 2 – PRODUCTS

# 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with these specifications, pipe support systems shall be:
  - 1. Nystrom; 9300 73rd Avenue N, Minneapolis, MN 55428; phone (800) 547-2635; <u>www.Nystrom.com</u>
  - 2. Balco, Inc.; 2626 S. Sheridan, Wichita, KS 67217; phone (800) 767-0082; www.balcousa.com
- B. Pre-approved equal as reviewed by the Architect and Owner per section 01 25 00 Substitution Procedures.

### 2.2 ASSEMBLY DESCRIPTION

- A. Furnish units in longest practicable lengths to minimize field splicing.
- B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

### 2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and as defined in the Contract Drawings.
- B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to ASTM E 1966 by a qualified testing agency.
  - 1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.
- C. Expansion Joint Design Criteria: Refer to Contract Drawings
  - 1. Type of Movement: Thermal and seismic
    - a. Nominal Joint Width: to be field verified and identified in the submittal process.
    - b. Minimum Joint Width: Nominal minus 50%
    - c. Maximum Joint Width: Nominal plus 50%
      - EXPANSION CONTROL 07 95 00 - 3

# 2.4 EXTERIOR ROOF EXPANSION JOINT COVERS

- A. Membrane-covered, Bellow-type Roof Expansion Joint Cover with Concealed Attachment Flanges:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Nystrom, Inc.; Model EWCF
  - 2. Design Criteria:
    - a. Bellow Size: Nominal structural gap plus 1 inch
    - b. Material:
      - 1) Flange: Aluminum 0.032 inch (0.81 mm)
      - 2) Bellow: Flexible Membrane Cover: 60 mil (1.5 mm) EPDM sheet
      - 3) Color: Black
      - Attachment Method: Concealed Attachment Flanges: 1 3/8 inch (35 mm) wide by .015 inch (0.4 mm) thick tin strip wrapped with neoprene-coated nylon fabric and Mechanical fasteners.
      - 5) Fire-Resistance Rating: Refer to 2.6 and 2.7 below
      - 6) Moisture Barrier: Manufacturer's standard

### 2.5 ROOF-TO-WALL EXPANSION CONTROL

- A. Flexible expanded rubber membrane and closed cell foam bellow with two 4 inch (102 mm) metal flanges, surface mount, waterproof; accommodating seismic movement with lateral shear.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Nystrom, Inc.; Model EEJW
  - 2. Design Criteria:
    - a. Bellow Size: Nominal structural gap plus 1 inch
    - b. Material:
      - 1) Flange: Aluminum 0.032 inch (0.81 mm)
      - 2) Bellow: Flexible Membrane Cover: 60 mil (1.5 mm) EPDM sheet
      - 3) Color: Black

- Attachment Method: Concealed Attachment Flanges: 1 3/8 inch (35 mm) wide by .015 inch (0.4 mm) thick tin strip wrapped with neoprene-coated nylon fabric and Mechanical fasteners.
- 5) Fire-Resistance Rating: Refer to 2.6 and 2.7 below
- 6) Moisture Barrier: Manufacturer's standard

# 2.6 PREFORMED, FIRE RATED FOAM JOINT SEALS

- A. Fire Rated for 2 hour, seismic compression seal designed for use in horizontal, high movement joints. Expanding foam, watertight, wax and asphalt free, non-invasive anchoring compression seal.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Nystrom, Inc.; Model FHES2.
  - 2. Design Criteria:
    - a. Exposed Sight Line: Joint width
    - b. Nominal Joint Width: to be field verified and identified in the submittal process.
    - c. Minimum Joint Width: 1 inch
    - d. Maximum Joint Width: 3.75 inches
    - e. Material: Silicone bellows with foam sealant.
    - f. Attachment Method: Self-compression with silicone sealant and 2-part epoxy
    - g. Standard: Meets UL-2079, ASTM E 119, ASTM E 1966, and ASTM E 1399.

# 2.7 PREFORMED, FIRE BARRIER SYSTEM

- A. Fire Rated for 2 hour, seismic compression seal designed for use in horizontal, high movement joints. Expanding foam, watertight, wax and asphalt free, non-invasive anchoring compression seal.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Nystrom, Inc.; Model FLF.
  - 2. Design Criteria:
    - a. Exposed Sight Line: Joint width
    - b. Nominal Joint Width: to be field verified and identified in the submittal process.
    - c. Minimum Joint Width: 4 inches

- d. Maximum Joint Width: 20 inches
- e. Material shall be a flexible, high purity ceramic fiber blanket. Includes stainless steel foil, intumescent matrix and fire resistive cloth as required to achieve desired protection and endurance rating.
  - Metal Attachment Retainer as required by project conditions - shall be pre-formed metal profile with manufacturer's standard hardware and fasteners to provide proper attachment of fire barrier assembly to adjoining construction.
  - 2) Accessories Provide necessary assembly hardware, splice transition pieces and anchors required for complete installation.
- f. Attachment Method: Mechanical fasteners
- g. Standard: Meets UL-2079, ASTM E1299, and ASTM E 1966

# PART 3 – EXECUTION

- 3.1 INSPECTION
  - A. Examine surfaces and blockouts where architectural joint systems will be installed for installation tolerances and other conditions affecting performance of work.
    - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare surfaces using methods recommended by the manufacturer for achieving the required results within project conditions.
- B. Corner blockouts should be square, level, free of spalling or laitance, and meet the dimensions shown on shop drawings. Repairs should be made using appropriate materials as recommended by concrete repair material manufacturer, based on project-specific conditions.
- C. Clean dirt, debris, and other contaminants from both the blockout and joint opening.
- 3.3 INSTALLATION
  - A. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.
  - B. Install components and accessories to comply with manufacturer's instructions.

- 1. Exterior conditions: Heat weld splices and intersections to form a continuous joint system.
- C. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent movement or misalignment.
- D. Where required install flexible fire barrier to comply with manufacturer's instructions.

# 3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over joints. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION

# SECTION 08 11 13

# HOLLOW METAL DOORS AND FRAMES

## PART 1 – GENERAL

## 1.1 DESCRIPTION

- A. Related Documents: Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 specification Sections apply to Work of this Section as if printed herein.
- B. Section Includes: Work shall include but not be limited to installation of doors, frames, and hardware. Requirements for materials, fabrications, and installation of hollow metal doors, pressed metal frames for doors, pressed metal cased openings, and associated accessories indicated on Drawings and necessary to complete the work.
- C. Related Sections:
  - 1. Section 05 05 19 Post-Installed Concrete Anchors
  - 2. Section 07 92 00 Joint Sealants
  - 3. Section 08 71 00 Door Hardware
  - 4. Section 09 91 00 Painting
- D. Scope:
  - 1. Fabrication, materials, and installation of metal doors in pressed metal frames.

### 1.2 QUALITY ASSURANCE

- A. Acceptable door and frame manufacturers: Security, Titan; Amweld Building Products; Steelcraft Manufacturing Co.;
  - 1. All metal doors and frames shall be furnished by one single manufacturer.
  - 2. Provide fire labels on all required door assemblies.
- B. References and Standards:
  - 1. American Society for Testing and Materials (ASTM) A653M, C236 and E413
  - 2. Steel Door Institute (SDI 100) "Recommended Specifications for Standard Steel Doors and Frames"
  - 3. UL 10 C Standard for Positive Pressure Fire Test of Door Assemblies
  - 4. NFPA 80 Fire Doors and Windows

- 5. NFPA 252 Fire Tests for Door Assemblies
- 6. CBC Standard 12-7-4 Fire Door Assembly Tests
- 1.3 SUBMITTALS (Submit under the provisions of Section 01 33 00).
  - A. Manufacturer's literature describing products per Section 01 33 00.
  - B. Shop Drawings: Include illustrations and schedule of finish hardware, door and frame size, type, material, construction, finishing, anchoring, accessories, and location and preparation for installing hardware.
  - C. Method of attachment subject to Architects approvals.
  - D. Before site delivery, identify type and size of each door and frame in way markings will not damage finish.
  - E. Certify that doors exceed infiltration rates per UL 1784.
  - F. Furnish templates for installation of all hardware.
- 1.4 PRODUCT DELIVERY AND STORAGE
  - A. Deliver all materials in protective packaging and store as recommended by the manufacturer within a dry enclosed space in a manner that will prevent rust and damage. Do not create a humidity chamber by using plastic or canvas shelter that is not adequately vented.

### PART 2 – PRODUCTS

### 2.1 MATERIALS

- A. General: Fabricate to sizes required to fit existing conditions or as indicated on the Contract Drawings, providing necessary clearances and bevels to permit operation without binding and to accommodate thresholds where required. Doors shall be free from warp, wave, buckle or other defect.
  - 1. Use of excessive metallic filler to conceal manufacturing defects is not acceptable.
- B. Flush Door Construction: All doors shall be fabricated with face sheets of 16 gauge steel. Doors shall be flush with edge seams weld filled and ground smooth. Bevel lock and hinge edges 1/8" in 2". Doors shall be provided with top and bottom 14 gauge steel channels welded within the door. Exterior doors shall have a top cap to protect against weather infiltration. Doors shall be reinforced, stiffened and sound deadened with impregnated draft having honey comb core completely filling inside of door and laminated to inside of face of panels. Outswinging exterior doors shall be provided with top caps for protection against weather.
  - 1. Exterior doors shall be insulated with expanded polystyrene core inside door using 1 lb. density, P.C.F. regular grade expanded polystyrene per ASTM C578, types 1 and 2.

- 2. Doors shall be fire labeled as required and as indicated on the drawings.
- C. Preparation for Hardware: Doors shall be mortised, reinforced, drilled and tapped at the factory from templates for all hardware listed in the hardware schedule. Doors shall also be reinforced for surface applied hardware such as closers, checks, escutcheons and kick plates, the drilling and tapping for which is to be done in the field by the door erector.
  - 1. Reinforcement shall consist of 12 gauge flat steel for locksets and latchsets; 14 gauge for surface applied hardware, except butts, which shall have 3/16" thick plate.
    - a. Provide reinforcement on both faces of doors for surface mounted closers, whether or not closers are indicated.
  - 2. All doors to receive cylindrical locksets, panic devices, or latchsets shall be provided with reinforcing unit as recommended by lock manufacturer.
  - 3. All doors shall have steel sleeves through the door at closer locations. Sleeves shall be pressed into place and welded. Closers shall be thru bolted with sex bolts. Sleeve to prevent doors from denting during the tightening of the closer bolts.
- D. Hardware Mounting Heights and Door Clearances: Refer to Section 08 71 00.

# 2.3 METAL FRAME FABRICATION

- A. General: Frames shall be welded type in accordance with CS242 as minimum requirements, plus additional requirements specified herein. Shop fabricate with straight arises, edges and corners; surface free from warp, wave, buckle, dents or other defects. Use of excessive metallic filler to conceal manufacturing defects is not acceptable.
  - 1. Provide all pressed metal frames for doors and windows indicated.
- B. Fabrication: Fabricate to cross section profiles as shown, depth as indicated to suit wall thickness. Field verify wall thickness and rough opening prior to fabrication.
  - 1. Welded frames shall have header and jambs secured at corners by internal welding of faces or by welding of mechanical interlock; exposed joints finished to provide a smooth surface for painting. Welding per applicable standards of AWS for high grade hollow metal work.
  - 2. Unless otherwise indicated, frames shall be fabricated from 16 gauge metal.
- C. Anchors: Frames shall be anchored to structure with anchors as indicated, and as specified herein. Where anchorage is not specifically delineated, anchorage shall be as for similar assembly, or approved manufacturer's standard type, to securely fasten frames to wall construction involved (wire anchors not acceptable); also provide adjustable floor anchor at bottom of each door jamb. Provide minimum 2 anchors at end of frames. Anchors shall provide stiffness

and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Max 1/16" torque allowed.

- D. Preparation for Hardware: Frames shall be prepared at the factory for all hardware using templates furnished by hardware supplier. Locations of miscellaneous hardware shall conform to the recommendations of the Door & Hardware Institute. Make cutouts, reinforce, drill and tap for all mortise type hardware. Reinforce for surface applied hardware, the drilling and tapping for which is to be done in the field by door erector.
  - 1. All hardware cutouts shall have steel plate reinforcements with tapped holes welded to frame. Reinforcement shall include 3/16 inch butt reinforcement; 12 gauge lock strike; and 14 gauge for surface applied items.
  - 2. Provide reinforcement at head of frames for surface mounted closer whether or not closers are indicated.
  - 3. Provide at lock jambs of frames holes for three (3) rubber door silencers. Omit holes at frames to receive unitized weatherstripping; refer to Section 08 71 00.
- E. Removable Spreaders: Provide removable metal spreaders for all three sided of frames to prevent damage during shipment and handling.
- F. Fire label doors and frames: Fire rated assemblies to have metal label fastened to the jamb indicating the fire rating and Test Agency name. Do not paint over label.
- 2.4 FINISH
  - A. Doors and Frames shall be leveled and ground smooth. Apply mineral filler to eliminate weld scars and other blemishes.
  - B. Shop priming: All surfaces shall be cleaned, phosphatized, and given one coat baked-on rust-inhibiting prime paint in accordance with the Steel Door Institute Specification "Test Procedure and Acceptance Criteria for Prime Painted Steel Doors and Frames".
    - 1. In addition, all unexposed surfaces of exterior frames shall be given a heavy coating of an asphaltic paint to prevent rust from moisture that may occur.
  - C. Color of doors and all frames shall be field painted per 09 91 00. Color as selected by Architect.

## PART 3 – EXECUTION

- 3.1 EXAMINATION
  - A. Verify that opening sizes and tolerances are acceptable.

## 3.2 INSTALLATION

A. Door Installation: Fit hollow metal doors accurately in their respective frames within clearances indicated under Section 08 71 00. Insure Smooth swing and proper closure with frame.

# 3.3 ADJUST AND CLEAN

- A. Prime Coat Touch-Up: Immediately after erection, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Touch-up shall not be obvious.
- B. Final Adjustments: Check and readjust operating finish hardware in door and frame metal work just prior to final inspection. Leave work in complete and proper operating condition.
- C. Defective Work: Remove and replace defective work, including doors and frames which are warped, bowed or otherwise damaged as directed by the Architect, with no additional cost to Owner.
- D. Protection: Protect installed door and frame metal work against damage from other construction work.

END OF SECTION

# SECTION 08 33 23

# OVERHEAD COILING DOORS

## PART 1 – GENERAL

## 1.1 DESCRIPTION

- A. Related Documents: Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 specification Sections apply to Work of this Section as if printed herein.
- B. Section Includes: Work shall include but not be limited to the fabrication and installation of overhead coiling doors, guide rail system, electric drive motor, and hardware. Requirements for materials, fabrications, and installation of coil-up doors and all related accessories indicated on Contract Drawings and necessary for a complete operational and secure system.
- C. Related Sections:
  - 1. Section 04 22 00 Concrete Unit masonry
  - 2. Section 05 05 19 Post-Installed Concrete Anchors
  - 3. Section 05 50 00 Metal Fabrication
  - 4. Section 07 92 00 Joint Sealants
  - 5. Section 09 91 00 Painting
  - 6. Division 26 Electrical
- D. Scope: Fabrication, materials, and installation of overhead coil-up doors, guide rail support systems, electric drive motor, and safety systems.

### 1.3 REFERENCES

- A. ANSI/DASMA 108 American National Standards Institute Standard Method For Testing Sectional Garage Doors And Rolling Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference.
- B. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.
- C. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM A 666 Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ASTM A 924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- F. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).

G. NEMA MG 1 - Motors and Generators.

# 1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

### 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Details of construction and fabrication.
  - 4. Installation instructions.
- C. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years' experience in the fabrication and installation of coiling doors.
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weather tight location.

# 1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.9 COORDINATION

A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

### 1.10 WARRANTY

- A. Warranty: Manufacturer's limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.
- B. Warranty: Manufacturer's limited door system warranty for 2 years for all parts and components.

# PART 2 – PRODUCTS

# 2.1 MANUFACTURERS

- A. Manufacturer List: Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules, and Specifications:
  - 1. Overhead Door Corporation; 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067; (800) 275-3290; <u>www.overheaddoor.com</u>
  - 2. Wayne Dalton; (855) 493-3667; <u>www.wayne-dalton.com</u>
  - 3. Raynor Worldwide; 1101 East River Road, Dixon, IL 61021-0448; (815) 288-1431; <u>www.raynor.com</u>
- B. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.

# 2.2 ROLLING SERVICE DOORS:

- A. The basis of design shall be: Stormtite Insulated Rolling Service Doors Model 625 by Overhead Door Corporation.
  - 1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
    - a. Flat profile type F-265i for doors up to 40 feet (12.19 m) wide.
    - b. Front slat fabricated of: 22 gauge stainless steel
    - c. Back slat fabricated of: 24 gauge stainless steel

- d. Slat cavity filled with CFC-free foamed-in-place, polyurethane insulation.
  - 1) R-Value: 7.7, U-Value: 0.13.
  - 2) Sound Rating: STC-21.
- 2. Performance:
  - a. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
  - b. Installed System Sound Rating: STC-21 as per ASTM E 90.
  - c. U-factor: 0.91 NFRC test report, maximum U-factor of no higher than 1.00.
  - d. Air Infiltration: Meets ASHRAE 90.1 & IECC 2012/2015 C402.4.3 Air leakage <1.00 cfm/ft2.
- 3. Slats and Hood Finish:
  - a. Stainless Steel: Slats and hood shall be stainless steel finished as follows.
    - 1) Finish: No. 4 satin finish.
- 4. Weatherseals: Vinyl bottom seal, exterior guide and internal hood seals.
- 5. Bottom Bar: Two stainless steel angles minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.
- 6. Guides: Three structural steel angles.
- 7. Brackets: Stainless steel to support counterbalance, curtain and hood.
- 8. Finish; Bottom Bar, Guides, Headplate and Brackets: PowderGuard Premium powder coat color as selected by the Architect.
- 9. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
- 10. Hood: Provide with internal hood baffle weatherseal. Stainless steel, 24 gauge hood with intermediate supports as required.
- 11. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.
  - a. Sensing Edge Protection: Electric sensing edge.
  - b. Operator Controls:

- 1) Key operation with open, close, and stop controls.
- 2) Controls for both interior and exterior location
- 3) Controls surface mounted.
- c. Motor Voltage: 115/230 single phase, 60 Hz.
- 12. Wind Load Design: Wind load criteria shall be as defined on the structural drawings cover sheet.
- 13. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.
- 14. Locking: Interior slide bolt lock for electric operation with interlock switch.
- 15. Wall Mounting Condition: Face-of-wall mounting.

# 2.3 ROLLING FIRE SERVICE DOORS

- A. The basis of design shall be: Rolling fire service door model FireKing Model 630 by Overhead Door Corporation
  - 1. Label: Provide fire doors certified with the following listing.
    - Rolling fire doors up to 152 sf (14.12 sm) and not exceeding 13 feet 6 inches (4.11 m) in width or height shall receive the UL or ULC 3-Hour Class A Label for installation on masonry or steel jamb walls, face mounted or between jambs. Door may be welded to the face of steel jambs.
  - 2. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
    - a. Flat profile type F-265 for doors thru 14 feet (4.27 m) wide by 12 feet (3.65 m) high, fabricated of:
      - 1) 22 gauge stainless steel.
  - 3. Finish:
    - a. Stainless Steel: Slats shall be stainless steel finished as follows.
      - 1) Finish: No. 4 satin finish.
  - 4. Bottom Bar: Two stainless steel angles minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.
  - 5. Guides: Three structural steel angles.
    - a. Fastening Guides to Masonry Fire Walls: UL listed for fire and smoke in accordance with manufacturer's listing.
- 6. Brackets:
  - a. Hot rolled steel to support counterbalance, curtain, and hood.
- 7. Finish; Bottom Bar, Guides, and Brackets:
  - a. Finish: PowderGuard Zinc base coat, gray with PowderGuard Textured powder color as selected by the Architect.
- 8. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
- 9. Hood:
  - a. Fabricate of 24 gauge galvanized primed steel minimum for wall openings thru 19 feet (5.79 m) wide.
  - b. Hood equipped with thermally controlled, internal, galvanized steel flame baffle as required for FM listing.
- 10. Electric Motor Operation: Provide electric operator as listed in the door UL file, for size as recommended by manufacturer to move door in either direction.
  - a. Floor Resettable Electric Motor Operation.
  - b. Sensing Edge Protection:
    - 1) Electric sensing edge.
  - c. Operator Controls:
    - 1) Key operation with NEMA 1 interior, NEMA 4 exterior, surface and flush mounted open, close, and stop controls.
- 11. Automatic Closure Standard Fire Door: UL approved release mechanism equipped with a 165 degree fusible link.
  - a. Doors will be equipped with chain hoist release mechanism, requiring only one sash chain to be routed to the operated side (sash chain not required to be routed to adjusting wheel side.)
    - 1) Release mechanism includes planetary gear differential system.
    - Door will close by a thermally actuated link rated @165 degrees F, or by an optional listed releasing device, or by manually activating the release handle.
    - 3) All counterbalance spring tension shall be maintained when the release mechanism is activated.

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- 4) After closing by manual activation of the release handle, the door shall be able to be reset by one person from one side of the door (re-engaging the release handle). No tools are required to reset the release mechanism.
- b. Doors will be equipped with floor resettable electric motor operation system, requiring only one sash chain to be routed to the operated side (sash chain not required to be routed to adjusting wheel side.)
  - 1) Release mechanism includes planetary gear differential system.
  - Door will close by a thermally actuated link rated @165 degrees F, or by an optional listed releasing device, or by manually activating the release handle.
  - 3) All counterbalance spring tension shall be maintained when the release mechanism is activated.
  - 4) After closing by alarm activation with power on the electric motor, the door shall be able to be reset by resetting the alarm system without additional tools required.
- c. Fire Sentinel time-delay release mechanism provides an added measure of safety to control the doors' closure.
- 12. Locking:
  - a. Interior slide bolt lock for electric operation with interlock switch.
- 2.4 FIRE SENTINEL TIME-DELAY RELEASE
  - A. Model FSCX24V Release Device: For motorized doors operating on a voltage of 24VDC with battery backup.
    - 1. Release device shall be used in conjunction with an appropriate UL 325rated commercial door operator, either a gearhead, jackshaft, or hoist operator equipped with auxiliary open and close limit switches, to create a door closing system.
    - 2. Capable of holding and releasing up to a 40 lb. load imposed by a fusible link/sash chain assembly attached to a release mechanism within the door construction.
    - 3. Provide with an internal battery backup system capable of providing up to 24 hours of battery power to support alarm logic, smoke detector, release capability and audible and visible signaling appliances. Device shall monitor battery charge and annunciate the need for battery replacement via an integral sounder; a green, enclosure-mounted LED that indicates the presence of the battery backup system.

- a. Battery backup/power system shall contain a management system providing trickle charge capabilities.
- b. During a power outage, and upon depletion of the battery, the device will initiate door closure by releasing the fusible link/sash chain assembly and initiating gravity closure of the door.
- c. A DIP-switch selectable feature shall provide the capability of operating on battery power upon loss of line power or closing the door through the release of the fusible link assembly initiating gravity closure of the door.
- 4. Includes DIP-switch selectable delay settings of 10, 20, or 60 seconds upon alarm activation to allow for passageway clearance before initiating door closure.
- 5. Capable of receiving an alarm input from compatible 2-wire normally open smoke detectors, 4-wire normally open smoke detectors, or normally open heat detectors, or input from a fire alarm control panel via a relay module providing a Form C dry contact output to the release device.
  - a. Capable of receiving input from a maximum of two smoke detectors.
  - b. Use with an End-of-Line (EOL) device to ensure the integrity of the wiring.
- 6. Provide with relay and trouble outputs to provide notification to a fire alarm control panel when an alarm or trouble state exists.
- 7. Circuit board shall have diagnostic LEDs to assist with field installation by indicating alarm or trouble conditions present within the smoke detector loops, as well as activation of the auxiliary close limit switch.
- 8. Includes an enclosure-mounted test switch that simulates an alarm condition when depressed and held for a length of time equal to the DIP-switch selectable delay setting, either 10, 20, or 60 seconds. A remote key test switch is also provided to simulate an alarm condition during testing procedures.
- 9. Hold open/release device shall recognize that the door is in the closed position and where motor driven, be capable of sensing that power is available to the motor. The device may be wired to close on alarm.
- 10. Upon alarm, the device shall offer the DIP-switch selectable feature of motorized door closure through the operator or bypassing the operator and initiating gravity door closure by releasing the fusible link assembly and engaging the door's release mechanism.
- 11. Audible and visual signaling appliances shall be provided to annunciate closure due to alarm or power loss conditions.
- 12. Device shall provide three-time obstruction cycling of the door through the operator.

- a. An electric sensing edge (by others) attached to the bottom edge of the door, and connected to both the device and the operator.
- b. Upon contact by the sensing edge with an obstruction, the closing door shall reverse and the device will instruct the operator to repeat the attempt at closure two additional cycles.
- c. Failure to reach the closed position will activate the one of two selectable actions.
- 13. Release device shall reverse the direction of the door through the operator upon the sensing edge making contact with an obstruction and repeat the attempt to achieve closure for two additional cycles.
  - a. Mode of operation upon failure to close the door shall be one of two DIP-switch selectable options
    - Failure to reach the closed position upon completion of the closure cycle or within a factory set time limit will result in the door being lowered by the operator upon the object. The door will rest on the obstruction until the obstruction is removed, at which point the door will resume closure through the operator to a fully closed position.
    - 2) Failure to reach the closed position upon completion of the closure cycle or within a factory selected time limit will result in gravity closure of the door. The door will rest on the obstruction until the obstruction is removed, at which point door closure shall be achieved through gravity drop.
  - b. Device shall provide a DIP-switch selectable 4-minute or 2-minute safety timer setting that will initiate gravity door closure if the operator close limit is not completed with the selected time or one of the modes of operation upon encountering an obstruction is not completed.
  - c. Loss of power to the operator or release device an alarm condition will result in gravity closure of the door.
- 14. Upon successful test completion of door closure through the operator with no obstructions encountered, the release device shall offer the DIP-switch selectable feature of allowing automatic open after the test input is cleared.
- 15. Release device shall offer a dry contact relay that may be used to activate signaling appliances or other external signaling functions.

## PART 3 – EXECUTION

## 3.1 EXAMINATION

A. Verify opening sizes, tolerances, and conditions are acceptable.

- B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Concrete Unit Masonry wall surfaces are to be ground smooth and plumb to insure door track and head achieve full bearing and a tight fit.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Division 26. Complete wiring from disconnect to unit components.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00.
- G. Install perimeter trim and closures.
- H. Instruct Owner's personnel in proper operating procedures and maintenance schedule.
- I. Turn over operation keys and control devices to Owner and receive signed transmittal for same.

#### 3.4 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.

#### 3.5 CLEANING

A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

- B. Remove packing labels and visible layout markings. This includes from all door components and also from adjacent building elements. Return finish of surfaces to original condition after removal of labels and markings.
- C. Touch-up, repair, or replace damaged products before Substantial Completion.

# 3.6 PROTECTION

A. Protect installed products until completion of project.

# END OF SECTION

# SECTION 08 45 23

#### FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

#### PART 1 – GENERAL

#### 1.1 SUMMARY

- A. Section includes the pre-engineered self-supporting insulated translucent sandwich panel skylight system and accessories as shown and specified. Work includes providing and installing:
  - 1. Flat factory prefabricated structural insulated translucent sandwich panels
  - 2. Aluminum installation system
  - 3. Aluminum flashing attached to skylights
- B. Related Sections:
  - 1. Section 06 10 00 rough Carpentry
  - 2. Section 07 56 00 Fluid-Applied Roofing
  - 3. Section 07 60 00 Flashing and Sheet Metal
  - 4. Section 07 92 00 Joint Sealants

## 1.2 SUBMITTALS

- A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of skylight components.
- B. Submit shop drawings. Include elevations and details.
- C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.
  - 1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
  - a. Sandwich panels: 14" x 28" units
  - b. Factory finished aluminum: 5" long sections
- D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.
- E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously

completed reports will be acceptable if for current manufacturer and indicative of products used on this project.

- 1. Reports required shall include:
  - a. International Building Code Evaluation Report
  - b. Flame Spread and Smoke Developed (UL 723) Submit UL Card
  - c. Burn Extent (ASTM D 635)
  - d. Impact Strength (UL 972)
  - e. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
  - f. Bond Shear Strength (ASTM D 1002)
  - g. Fall Through Resistance (ASTM E 661)
  - h. Insulation U-Factor (NFRC 100) and (NFRC 700)
  - i. Solar Heat Gain Coefficient (NFRC or Calculations)
  - j. Air Leakage (ASTM E 283)
  - k. Structural Performance (ASTM E 330)
  - I. Water Penetration (ASTM E 331)
  - m. Class A Roof Covering Burning Brand (ASTM E 108)
  - n. UL Listed Class A Roof System (UL 790) (Optional) Submit UL Card

## 1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications
  - 1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope and location. At least three of the projects shall have been in successful use for ten years or longer.
  - 2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
  - 3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177

"Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES.

B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified skylight systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

## 1.4 PERFORMANCE REQUIREMENTS

- A. The manufacturer shall be responsible for the configuration and fabrication of the complete skylight panel system.
  - 1. When requested, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - Standard skylight system shall have less than 0.01 cfm/ft<sup>2</sup> air leakage by ASTM E 283 at 6.24 PSF (50 mph) and no water penetration by ASTM E 331 at 15 PSF; and structural testing by ASTM E 330.
  - 3. Structural Loads; Provide skylight system capable of handling the following loads:
    - a. Tested to ASTM E661, exceeding OSHA 1910.22 for fall protection without the need for additional protection like external screens or fixed railings
    - b. Live Load: 20 PSF
    - c. Snow Load: 0 PSF
    - d. Wind Load: 110 mph

#### 1.5 DELIVERY STORAGE AND HANDLING

- A. Deliver panel system, components, and materials in manufacturer's standard protective packaging.
- B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

#### 1.6 WARRANTY

- A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering, defects in accessories, insulated translucent sandwich panels and other components of the work.
- B. Extended Warranty:
  - 1. Material and Workmanship: 5 years

# 2. Panel Construction: 10 years

# PART 2 – PRODUCTS

## 2.1 MANUFACTURER

- A. The basis for this specification is for products manufactured by Kalwall Corporation. Other manufacturers may bid this project provided they comply with all of the performance requirements of this specification and submit evidence thereof. Listing other manufacturers' names in this specification does not constitute approval of their products or relieve them of compliance with all the performance requirements contained herein.
- B. Kalwall Corporation; phone (800) 258-9777; www.kalwall.com

## 2.2 PANEL COMPONENTS

- A. Face Sheets
  - 1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
    - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
    - b. Face sheets shall not deform, deflect or drip when subjected to fire or flame.
  - 2. Interior face sheets:
    - a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 and smoke developed no greater than 250 when tested in accordance with UL 723.
    - b. Burn extent by ASTM D 635 shall be no greater than 1".
  - 3. Exterior face sheets:
    - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
    - Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 70 ft. lbs. without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972.
  - 4. Appearance:

- a. Exterior face sheets: Smooth, 0.070" thick and White in color
- b. Interior face sheets: Smooth, 0.045" thick and White in color
- c. Face sheets shall not vary more than ± 10% in thickness and be uniform in color.
- B. Grid Core
  - 1. Standard I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".
  - 2. I-beam Thermal break: Minimum 1", thermoset fiberglass composite
- C. Laminate Adhesive
  - 1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
  - 2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
  - 3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
    - a. 50% Relative Humidity at 68° F: 540 PSI
    - b. 182° F: 100 PSI
    - c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
    - d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

## 2.3 PANEL CONSTRUCTION

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
  - 1. Thickness: 2-3/4"
  - 2. Light transmission: a minimum of 15%
  - 3. Solar heat gain coefficient shall not exceed 50
  - 4. Panel U-factor by NFRC certified laboratory: 2-3/4" thermally broken grid with a U-factor of 0.23.

FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

- 5. Complete insulated panel system shall have NFRC certified U-factor of 0.42.
- 6. Grid pattern: Nominal size 12" x 24"; pattern Shoji.
- B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10' 0" span without a supporting frame by ASTM E 72.
- C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.
- D. Thermally broken panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.
- E. Skylight System:
  - 1. Skylight system shall pass Class A Roof Burning Brand Test By ASTM E 108.
  - 2. Skylight system shall be UL listed as a Class A Roof by UL 790, which requires periodic unannounced inspections and retesting by Underwriters Laboratories.
- F. Skylight System shall meet the fall through requirements of OSHA 1910.23 as demonstrated by testing in accordance with ASTM E 661, thereby not requiring supplemental screens or railings.
- 2.4 BATTENS AND PERIMETER CLOSURE SYSTEM
  - A. Closure system:
    - 1. Extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
    - 2. Skylight perimeter closures at curbs shall be factory sealed to panels.
  - B. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.
  - C. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.
  - D. Finish:
    - 1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be clear anodized.
- 2.5 STRUCTURAL SUPPORT FOR STANDARD MODELS
  - A. Pyramid skylights: Pyramids to 16'-0" square shall have concealed support integral with the installation system. Pyramids 17'-0" to 20'-0" shall have factory prefabricated exposed aluminum box beam supports at the hips only. 27.25° slope. Aluminum curb cap extrusions and flashing shall be supplied.

# PART 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Installer shall examine substrates, supporting structure and installation conditions.
- B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Metal Protection:
  - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
  - 2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

#### 3.3 INSTALLATION

- A. Install the skylight system in accordance with the manufacturer's suggested installation recommendations and approved shop drawings.
  - 1. Anchor component parts securely in place by permanent mechanical attachment system.
  - 2. Accommodate thermal and mechanical movements.
  - 3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

## 3.4 FIELD QUALITY CONTROL

- A. Water Test: Installer to test skylights according to procedures in AAMA 501.2.
- B. Repair or replace work that does not pass testing or that is damaged by testing and retest work.
- 3.5 CLEANING
  - A. Clean the skylight system interior and exterior immediately after installation.
  - B. Refer to manufacturer's written recommendations.

## END OF SECTION

FIBERGLASS-SANDWICH-PANEL ASSEMBLIES 08 45 23 - 7

## SECTION 08 71 00

#### DOOR HARDWARE

#### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

- A. Factory fabricated and finished door hardware systems. These shall include all required hardware for door functions including but not limited to the following:
  - 1. Hinges
  - 2. Exit Devices and Accessible hardware
  - 3. Closers, bumpers, and silencers
  - 4. Kick plates and thresholds
  - 5. Additional hardware required for a complete and operational door hardware system.

#### 1.2 RELATED SECTIONS

- A. Section 05 05 19 Post-Installed Concrete Anchors
- B. Section 08 11 13 Hollow Metal Doors and Frames
- 1.3 SUBMITTALS
  - A. Submit product data, keying, and shop drawings indicating each required finish from each Manufacturer.
  - B. Submit final hardware schedule organized by "hardware sets," to indicate specifically the product to be provided for each item required on each door.
  - C. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

#### 1.4 QUALITY ASSURANCE

- A. Provide hardware tested and listed by UL or FM.
- B. Provide templates to each fabricator of doors and frames as required for hardware preparation.
- C. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying. Installer shall have a minimum of 5 years' experience installing hardware of this nature.

- D. Architectural Hardware Consultant Qualifications: Experienced with installations that are comparable in material, design, and extent to this Project, and certified by DHI as one of the following:
  - 1. AHC who is also an EHC.
  - 2. AOC.
- E. Source Limitations: Provide each type of door hardware from same manufacturer throughout the entire project.
- D. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
    - a. Exit Devices: Two years from date of Substantial Completion
    - b. Manual Closers: 10 years from date of Substantial Completion

#### PART 2 – PRODUCTS

- 2.1 NUMBER DESIGNATIONS
  - A. Numbers indicating hardware items are ANSI/BHMA standard number designations.
  - B. For specific model numbers indicated that basis-of-design, refer to the hardware schedule in Part 4 Schedule below.
- 2.2 FINISH AND BASE MATERIAL DESIGNATIONS
  - A. Finish and base material designations are indicated in accordance with ANSI BHMA A156.18 or the nearest traditional U.S. commercial finish.
    - 1. Provide 626 Satin Chromium Plates finish on all new hardware unless specified as Satin Stainless Steel herein.
- 2.3 CONTINUOUS GEAR HINGE
  - A. Not Required

# 2.4 HINGES

- A. Hinges shall be of one manufacturer as listed for continuity of design and consideration of warranty and shall be certified and listed by the following:
  - 1. Butts Hinges: ANSI/BHMA A156.1
- B. Butt Hinges:
  - 1. Hinge weight and size unless otherwise indicated in hardware sets:
    - a. Doors up to 36 inches (914 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of .134 inch (3.4 mm) and a minimum of 4-1/2 inches (114 mm) in height.
    - b. Doors from 36 inches (914 mm) wide up to 42 inches (1067 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of .145 inch (3.7 mm) and a minimum of 4-1/2 inches (114 mm) in height.
    - c. For doors from 42 inches (1067 mm) wide up to 48 inches (1219 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of .180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.
    - d. Width of hinge is to be minimum required to clear surrounding trim.
  - 2. Base material unless otherwise indicated in hardware sets:
    - a. Exterior Doors: 304 Stainless Steel
    - b. Interior Doors: Steel material
    - c. Fire Rated Doors: Steel or 304 Stainless Steel materials
    - d. Stainless Steel ball bearing hinges shall have stainless steel ball bearings. Steel ball bearings are unacceptable.

## 2.5 LOCKSETS

- A. Not Required
- 2.6 PANIC HARDWARE
  - A. Manufacturer: Detex, Von Duprin 99, Falcon, or equal
    - 1. Device shall be heavy-duty version that is non-handed and field configurable.
    - 2. Provide U.L. listed fire rated device as required in the contract drawings.
    - 3. Device shall be set up for rim latching unless otherwise required in the contract drawings.

- 4. Device shall be equipped for cylinder dogging by key matching the keying system within Site Operations. Coordinate with Owner's Representative.
- 5. Device shall be equipped with pull plate and cylinder for keyed operation. Keying shall be coordinated with building All-Section-Multi-Section key system.
- 6. Device shall be finished equal to 630 Brushed Stainless Steel
- 7. Device shall be placed with the centerline 38 inches above finished floor.
- 8. Device shall be rated for exterior use for doors at the Generator yard.

## 2.7 KEYING

- A. Keying for all cylinders in lever hardware, panic hardware, padlocks, etc. shall be as defined by the Owner's existing on-site standard. No substitutions will be accepted.
- B. Cylinders for night latch function and dogging shall be provided with FSIC cores and 5 sets of keys. Cylinders shall be Schlege Everest 6 pin core with D135 keyway. Owner's representative will provide final cylinders and keying to match Schlege FSIC core cylinders as the Owner's standard.

## 2.8 ELECTRIC STRIKES

A. Not Required

## 2.9 OVERHEAD CLOSERS

- A. Manufacturer LCN 5010 Series or equal. Closer shall be rated for weather exposure.
  - Closers shall be non-sized to provide a full range (1 to 4) closing power for all sizes, according to BHMA product standards (ANSI 156.4-1986, Table I) and shall be listed in BHMA Certified Products Directory complying with A156.4 test standards, to provide minimum closing force required to properly latch the doors. For barrier-free applications, closer spring power shall be adjustable to provide less than 5 pounds opening force for doors 36 inches to 48 inches wide.
  - 2. Closers shall utilize temperature stable fluid capable of withstanding temperature ranges of 120 degrees Fahrenheit to -30 degrees Fahrenheit without requiring seasonal adjustment of closer speed to properly close the door.
  - 3. High strength cast iron construction
    - a. Test to ANSI/BHMA A156.4 test requirements by BHMA certified testing laboratory.
  - 4. Closers shall be fully hydraulic and shall have full rack and pinion action with a shaft diameter of 11/16 inch and piston diameter of 1-1/2 inches.

- 5. Typical location of standard closer to be on private side of the door. Utilize a standard arm closer where ever possible.
  - a. All standard arm closers shall incorporate 1 piece solid forged steel stud shoulder bolts and shall be incorporated in regular arms and hold open arms.
- 6. Closer shall utilize full complement bearing at shaft to provide greatest load carrying capabilities of the shaft.
- 7. Pinion and pistons shall be hardened regardless of size, to provide durable wearing surfaces.
- 8. For hydraulic regulation, the closer shall incorporate tamper resistant, non-critical screw valves of v-slot design to reduce possible clogging from particles inside the closer.
- 9. Closers shall have separate and independent screw valve adjustments for latch speed, general speed, and hydraulic backcheck. Backcheck shall be properly located so as to effectively slow the swing of the door at a minimum of 10 degrees in advance of the dead stop location to protect the doorframe and hardware from damage.
- 10. Other closers to have forged steel main arms for durability, and esthetics for versatility of trim accommodation, high strength, and long life.
- 11. Built-in stop arms or cush stop arms are not acceptable.
- 12. Provide Manufacturer's 10-year warranty against manufacturing defects and workmanship.

## 2.10 HOLD OPENS, STOPS, AND BUMPERS

- A. Security door stops designed for use in high vandalism areas.
- B. Stop equal to Ives FS434 Floor stop 2 5/8" at exterior doors.
  - 1. Molded from black rubber. Replaceable.
  - 2. Provide concrete screws for attachment per section 05 05 19.

#### 2.11 SILENCERS & SEALS

- A. Provide silencers in metal door frames, unless weather stripping is provided; 3 per jamb at single-door frame and at pair doors provide 2 at each half at head frame, plus 3 each on astragal.
- B. Provide continuous weatherstrip / gasketing on exterior doors and provide smoke, light, or sound gasketing where indicated on hardware schedule. Provide non-corrosive fasteners for exterior applications.
  - 1. Perimeter gasketing: Apply to head and jamb, forming seal between door and frame.
  - 2. Meeting stile gasketing: Fasten to meeting stiles, forming seal when doors are in closed position.

- 3. Door bottoms: Apply to bottom of door, forming seal with threshold or floor when door is in closed position.
- 4. Sound Gasketing: Cutting or notching for stop mounted hardware not permitted.
- 5. Drip Guard: Apply to exterior face of frame header. Lip length to extend 4 inches (102 mm) beyond width of door.
- 2.12 ARMOR, KICK, AND MOP PLATES
  - A. Not Required
- 2.13 PUSH AND PULL PLATES
  - A. Not Required
- 2.14 REMOVABLE MULLIONS
  - A. Not Required

#### 2.15 THRESHOLDS

- A. Provide thresholds that meet ADA / current CBC accessibility requirements and as indicated in the schedule below. Thresholds shall be of extruded metal produced from 6063 aluminum alloy.
- B. Set thresholds for exterior and acoustical openings in full bed of sealant with lead expansion shields and stainless steel machine screws complying with requirements specified in other section of these specifications. Notched in field to fit frame by hardware installer. Manufacturer to be certified by the following:
  - 1. Thresholds: ANSI/BHMA A156.21.

## 2.16 FLUSH BOLTS AND COORDINATORS

A. Not Required

## 2.17 FASTENERS AND ANCHORS

- Provide finish hardware with necessary screws, bolts, or other fasteners of suitable type and size to securely anchor hardware for long life under heavy use. The following guidelines should be adhered to for fasteners and anchors. See also Section 05 05 19 Post-Installed Concrete Anchors.
  - 1. Finish on exposed portions of fasteners and anchors shall match finish of item being fastened.
  - 2. Sex bolts, toggle bolts, or other approved anchors shall be provided according to material to which hardware is applied. Provide sex bolts at closers on wood doors.
  - 3. Exposed screws shall have Phillips style heads.
  - 4. Use machine screws for hardware applied on metal.

5. Hardware fastened to concrete or masonry shall be provided with machine screws and "Star" type double expansion shields, or for screw sizes less than 1/4 inch, fasten with wood screws and Phillips "red head" plastic anchors, Fastway extruded vinyl anchors or "Star" plastic anchors, or equal. Lead shields or tampins shall not be used.

## PART 3 – EXECUTION

#### 3.1 HARDWARE INSTALLATION

- A. Refer to the Contract Drawings for the hardware Schedule.
- B. Provide hardware in strict accordance with Manufacturer's recommendations. Fasteners shall be threaded into drilled and tapped holes, no self-drilling or sheet metal screws affixing hardware to doors. Unless otherwise indicated, set finish hardware at the following heights or to match existing.
  - 1. Door Levers: Center 38 inches above finished floor.
  - 2. Push and Pull Plates: Center 38 Inches above finished floor.
  - 3. Top Hinge: Top 7 inches below head of frame.
  - 4. Bottom Hinge: Bottom 11 inches above finished floor.
  - 5. Center Hinge: Equal distance between top and bottom hinges.
- C. As required during progress of Work, remove and reset doors and hardware for placement of Work of other Sections.

#### 3.2 EXISTING HARDWARE

A. Existing hardware that is removed and not reused in the Work shall be given to the Owner's Representative.

#### 3.3 INSTALLATION COMPLIANCE

A. Provide each hardware item to comply with Manufacturer's instructions and recommendations.

## 3.4 HARDWARE ADJUSTMENT

A. Return to Project 1 month after acceptance, and adjust hardware to proper operation and function. Instruct Owner's Representative in proper maintenance and adjustment. Contractor responsible for schedule adjustment visit with Owner's Representative prior to project completion.

#### 3.05 CLEAN-UP

A. Remove all Manufacturer's protective packaging and clean all hardware of foreign material.

# END OF SECTION

## SECTION 09 91 00

#### PAINTING

#### PART 1 – GENERAL

#### 1.1 DESCRIPTION

- A. Related Documents: Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to Work of this Section as if printed herein.
- B. Section Includes: Description of requirements for materials and application of paints and finishes for surfaces applied at job site, except those specifically excluded under Sub-paragraph 2 below.
  - 1. Work includes, but is not limited to, painting of following items, materials, and spaces:
    - a. Conduits or piping exposed at roof areas that are not finished metal, such as stainless steel, chromium plated, bronze, aluminum, and similar finished materials, unless indicated otherwise. Paint all sides of segments of pipes and mounting hardware in exposed areas.
    - b. Sheet metal flashings not factory finished such as Parapet cap flashings, wall counter flashings, and mechanical curb counter flashings.
  - 2. Work does not include painting following items, materials or spaces:
    - a. Finished metal, such as stainless steel, chromium plated, bronze, aluminum, and similar finished materials, unless indicated otherwise.
    - b. Factory-finished materials, such as clay tiles, etc. unless otherwise specified.
  - 3. Surfaces for which painting is prohibited:
    - a. Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates, fire alarm devices, fire sprinkler heads, etc.
    - b. Elastomeric sealants or silicone sealants not designed for painting.
- D. Definitions:
  - 1. The term "paint" as used throughout these Specifications includes emulsions, enamels, paints, stains, varnishes, sealers, fillers and other coatings whether used as prime, intermediate or finish coat.

- 2. Factory Finish: Factory-applied painting system consisting of primer and finish coats.
- E. Related Sections:
  - 1. Section 07 19 16 Silane Water Repellents
  - 2. Section 07 60 00 Flashing and Sheet Metal
  - 3. Section 09 96 00 High Performance Coatings
  - 4. Section 09 96 46 Intumescent Painting
  - 5. Division 22 Plumbing
  - 6. Division 26 Electrical
  - 7. The requirements of Division 01 apply to the Work of this Section.

## 1.2 QUALITY ASSURANCE

- A. Applicator's Qualifications: All application of paint shall be done only by an application firm normally engaged in this business. All work shall be performed by qualified mechanics working under the supervision of an experienced supervisor.
- B. Paint Coordination: Provide finish coats which are compatible with prime coats used. Review other Sections of these Specifications in which prime paints are provided to ensure compatibility of total coatings system for various substrates. Upon request from other subcontractors, furnish information characteristics of finish materials proposed for use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect in writing of any anticipated problems using coating systems as specified with substrates primed by others.
- C. Compliance to EPA Policy: Furnish certification that all paint coatings furnished for project comply with the EPA Clean Air Act for permissible levels of volatile organic content for architectural coatings applied in California as designated by California Air Resources Board (CARB).
- 1.3 SUBMITTALS (Submit under provisions of Section 01 33 23)
  - A. Manufacturer's Data: Manufacturer's technical information describing products, including paint label analysis and application instructions for each material proposed for use. Reference literature to the Architect's material numbers and painting systems. Include manufacturer's statement that components are appropriate to each Painting System.
  - B. Samples: Selection of colors and finishes will be made by the Architect from samples submitted for his review and approval. Samples to be 8 inches x 10 inches in size, hand deliver brushed for each color selected.

# 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered to the site and stored in their original containers with seals unbroken and labels intact until time of use. Labels shall contain the following information:
  - 1. Name or title of material
  - 2. Manufacturer's stock number and date of manufacture.
  - 3. Manufacturer's name
  - 4. Contents by volume, for major pigments and vehicle constituents.
  - 5. Thinning and mixing instructions.
  - 6. Application instructions.
  - 7. Color name and number.
  - 8. Clean up instruction.
- B. Store all painting materials and equipment not in immediate use in areas assigned for that purpose. Store paints in ventilated area at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F.

#### 1.5 JOB CONDITIONS

- A. Environmental Requirements:
  - 1. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F unless otherwise permitted by paint manufacturer printed instructions.
  - 2. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F, unless otherwise permitted by paint manufacturer's printed instructions.
  - 3. Apply paint under dry and dust-free conditions. Do not apply paint in rain, fog, or mist; or when relative humidity exceeds 85%; or to damp or wet surfaces; unless otherwise permitted by paint manufacturer's printed instructions.
  - 4. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
  - 5. Provide adequate ventilation so that humidity cannot rise above the dew point of the walls.
- B. Illumination: Perform work under adequate and approved lighting conditions.

C. Protection: Properly protect floors and other adjacent work by drop cloths or approved coverings during painting operations.

## 1.6 WARRANTY

A. Warranty period shall be one (1) year for interior painting against paint failure due to surface conditions, oxidation, fading, for both materials and application. Any failure shall be repainted to new condition by contractor at no cost to the Owner.

#### PART 2 – PRODUCTS

#### 2.1 MATERIALS

- A. Materials for use on this project shall be "best" grade products of the types specified and listed below as regularly manufactured by the specified paint and varnish manufacturer. Materials not bearing the manufacturer's identification as standard "best" grade product of his regular line will not be considered for use. Materials listed hereunder are taken from various manufacturers listed above and shall be used as the standard required.
- B. Manufacturer's offering products, which comply with requirements of these Specifications, include the following: Dunn-Edwards, PPG, and Kelly-Moore. Products listed below are from the Dunn Edwards product line as a point of reference for make-up, quality, and performance.
- C. Materials (including primers, sealants and undercoats) selected for use for each type of surface shall be the product of a single manufacturer as listed above wherever possible. Use only thinners approved by paint manufacturer, and use only to recommended limits.
- D. Cleaning Solvent: Steel Structures Painting Council SSPC-SP1 1.
- E. Ferrous Metal Cleaner: Phosphoric acid (Fed. Spec. MIL-C-19329) shall be composed of phosphoric acid (85 percent) parts maximum, and isopropyl alcohol 15 parts.
- F. Galvanized Iron Cleaner: Acid wash, Galvaprime. Dilute with water according to the manufacturer's recommendations.
- G. Linseed Oil: Boiled type, complying with Fed. Spec. TT-O-364.
- H. Paint Materials: Refer to "Painting Schedules" hereinafter for paint products or materials and number of coats to be applied as finishes to surfaces on this project. Product numbers listed are as manufactured by Dunn-Edwards unless indicated otherwise (equivalent products of other manufacturers listed hereinbefore are also acceptable).

# 2.2 MIXING

- A. Color-tint sealers and undercoats to correspond with finish color. Vary color of successive coats sufficiently to distinguish between coats.
- B. Obtain the Architect's approval for adjustments of color on job.

C. Do not reduce any material unless directed to do so by the Architect, or unless recommended by materials manufacturer.

# PART 3 – EXECUTION

## 3.1 INSPECTION

- A. Applicator must examine areas and conditions under which painting work is to be performed and notify Contractor in writing, with a copy to Architect, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to applicator.
- B. Application of the first coat of any finishing process shall constitute applicator's acceptance of surfaces within any particular area except gypsum wallboard, which shall be inspected after painter applies the seal coat.
- C. Do not paint over dirt, rust, scale, grease, moisture, loose cement plaster, scuffed surfaces, or conditions otherwise detrimental to formation of durable paint film.

#### 3.2 SURFACE PREPARATION

- A. General:
  - 1. Perform preparation and cleaning procedures in strict accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.
  - 2. Remove items not to be finished painted, or provide surface-applied protection prior to surface preparation and painting operations. Reinstall removed items by workmen skilled in trades involved.
  - 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall on wet, newly painted surfaces.
- B. All Ferrous Surfaces required to be painted under this section shall be cleaned and treated as follows:
  - 1. Clean all rust, loose mill scale, grease, dirt, wax, old sealants, caulking and other deleterious matter by any effective means and treat with phosphoric acid or chemical etching compound as specified under "Materials". Rinse with water and dry thoroughly.
  - 2. Abraded or corroded spots on shop-coated surfaces shall be wire brushed and touched up with material similar to shop coat. Special care shall be exercised to remove wax, lubricants, and other coatings from rollform coated metals prior to painting.
- C. Galvanized and Zinc-Copper-Alloy Surfaces to be painted shall be solvent cleaned in accordance with Steel Structures Council Painting specification SSPC-SP 1-63 and treated with acid wash as specified under Article 2.01 herein.

- 1. Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
- D. Aluminum and Aluminum Alloy Surfaces to be painted shall be solvent cleaned to remove oil and grease and then treated with chromate metal primer as herein specified. Cleaning solvents and procedures shall conform to the Steel Structures Council Painting Specification SSPC-I-63.
- E. Equipment Installed with Factory Finish: Sand or etch finished surface to increase adherence of finish coats specified to be applied over factory finish.
- F. Other Surfaces: Prepare surface as recommended by paint manufacturer.

# 3.3 MATERIALS PREPARATION

- A. Mix and prepare painting materials in strict accordance with manufacturer's directions in room or area assigned for that purpose.
  - 1. Floor slabs used for storage and mixing of any paint materials shall be protected by temporary coverings that will not permit penetration or saturation of paint materials. Painting contractor shall be solely responsible for this protection.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir film which, may form on surface into material. Remove film and if necessary, strain materials before using.
- D. All necessary precautions shall be taken to prevent fire. Rags and waste soiled with paint shall be removed from the premises at the end of each day's work, or stored in metal containers with metal covers.

## 3.4 PAINT APPLICATION AND WORKMANSHIP

- A. General: All work specified herein shall be of highest quality possible for the specified finish and for the surface to which the finish is applied and that which will provide maximum durability. Finished surfaces shall be free from runs, drips, ridges, waves, laps, brush marks and variation in color, texture and finish.
  - 1. Apply paint by brush, roller, spray, or other acceptable practice in accordance with manufacturer's directions. Use brushes best suited for type of material being applied. Use rollers of carpet, velvet back, or high pile sheep's wool as recommended by paint manufacturer for material and texture required.
  - 2. Number of coats and paint film thickness required is same regardless of application method. Do not apply succeeding coats until previous coat has completely dried.

- 3. Apply additional coats when undercoats, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.
- 4. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.
- 5. Paint back sides of access panels, removable or hinged covers to match exposed surfaces.
- 6. Omit first coat (primer) on metal surfaces which have been shop primed and touch-up paint, unless otherwise indicated. Painting of mechanical and electrical work is limited to those items exposed in occupied spaces, except as otherwise specified or indicated.
- B. Minimum Coating Thickness: Apply each material at not less than manufacturer's recommended spreading rate.
- C. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
  - 1. Allow sufficient time between successive coatings to permit proper drying. Do not re-coat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.
- D. Prime Coats: Re-coat primed and sealed walls and ceiling where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.
- E. Pigmented (opaque) finishes: Completely cover to provide opaque, smooth surface of uniform finish, color, appearance, and coverage.
- F. Stipple Enamel Finish: Roll and re-distribute paint to even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.
- G. Brush Application: Brush-out and work brush coats onto surfaces in even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. Neatly draw all glass and color break lines.
  - 1. Brush apply primer or first coats, unless otherwise permitted to use mechanical applicators.
- H. Mechanical Applicators: Use mechanical methods for paint application when permitted by governing ordinances and trade union regulations. If permitted, limit to only those surfaces impracticable for brush applications.

- 1. Limit roller application (generally) to interior wall and ceiling finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
- 2. Confine spray application (generally) to metal work, and similar surfaces where hand brush work would be inferior, and other surfaces specifically recommended by paint manufacturer. Respirators shall be worn by all persons engaged in or assisting in spray painting operations.
  - a. Wherever spray applications is used, apply each coat to provide equivalent hiding of brush-applied coast. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.
- I. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.
- 3.5 INTERIOR PAINTING SCHEDULING (NOT USED)
- 3.6 EXTERIOR PAINTING SCHEDULING
  - A. Surfaces not required to be painted: Refer to Paragraph 1.01.B.2, above.
  - B. Exterior Surfaces All exposed surfaces shall be finished per the plans and specifications and at the direction of Owner. Color to be determined by the Owner during the submittal process.
    - Non-Ferrous and Aluminum Metals

       coat Acrylic primer (UGPR00-1 Ultra-Grip Premium)
       coats Waterborne Urethane Alkyd (ASHL50 Aristoshield)
    - Parapet Cap Flashing, Expansion Joints, doors and frames, and other Misc. Metals
       1 coat Acrylic primer (UGM00-WH Ultrashield Primer)
       2 coats Waterborne Urethane Alkyd (ASHL50 Aristoshield)
    - Concrete and Cement Plaster
       1 coat Acrylic primer (SFSL00-1 Surfaco Select)
       2 coats Waterborne Urethane Alkyd (ASHL40 Aristoshield)
  - C. For structural steel coating refer to section 09 97 13

# END OF DOCUMENT

## SECTION 09 96 46

#### INTUMESCENT PAINTING

#### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

- A. Furnish all materials, labor, equipment, and services necessary and incidental to the Installation of intumescent fire protection painting of structural steel framing members.
- 1.2 RELATED SECTIONS
  - A. Section 05 12 00 Structural Steel
  - B. Section 05 30 00 Metal Decking
- 1.3 REFERENCES
  - A. ANSI A2.1 Standard Test Method for Fire Tests of Building Construction and Materials.
  - B. ASTM International:
    - 1. ASTM D 1475 Standard Test Method For Density of Paint, Varnish, Lacquer, and Related Products.
    - 2. ASTM D 2369 Standard Test Method For Volatile Content of Coatings.
    - 3. ASTM D 3359 Standard Methods for Measuring Adhesion by Tape Test (Methods A and B)
    - 4. ASTM D 3960 Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
    - 5. ASTM D 4017 "Standard Test Method for Water in Paints and Paint Materials by Karl Fischer Method.
    - 6. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
    - 7. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Materials.
    - 8. ASTM E 283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
    - 9. ASTM E 662 Standard Guide for Measurement of Gases Present or Generated During Fires.
  - C. AZ/NZS 1425:2007 Western Australia DOC Test for LPG Storage Containers.

- D. BSS 476 Standard Test Method for Fire Tests of Building Construction and Materials.
- E. BSS 7239 Test Method for Toxic Gas Generation by Materials on Combustion.
- F. UBC 8.1 Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. DIN 4102, Part 8 Standard Test Method for Fire Tests of Building Construction and Materials.
- H. National Fire Protection Association (NFPA):
  - 1. NFPA 251 Standard Test Method for Fire Tests of Building Construction and Materials.
  - 2. NFPA 255 Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 3. NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room.
- I. UL 263 Fire Tests of Building Construction and Materials.
- J. UL 723 Test for Surface Burning Characteristics of Building Materials.
- K. UL-C-S101 Standard Test Method for Fire Tests of Building Construction and Materials.
- L. Uniform Building Code (UBC):
  - 1. UBC 7-1 Standard Test Method for Fire Tests of Building Construction and Materials.
  - 2. UBC 26-2, Test Method for Evaluation of Thermal Barriers.
  - 3. UBC 26-3, Room Fire Test Standard for interior of foam plastic systems met all criteria.

## 1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Manufacturer's data sheets on each product to be used.
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Verification Samples: For each finished product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product and finish.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store all materials in manufacturer's unopened, labeled packaging until ready for installation.
- B. Store above 65 degrees F (18 degrees C) for 48 hours prior to application.

#### 1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not expose applied product to rain, dew, snow, heavy fog, condensation or other forms of accumulated moisture or precipitation before having dried completely and a top coat of acrylic enamel, designed for the ambient environment, has been applied and allowed to dry.

#### PART 2 – PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer List: Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules and Specifications:
  - 1. Contego International; Carmel, IN 46032; (800) 434-6444; www.contegointernational.com
  - 2. FlameOff; 1110 Navaho Dr, Suite 110, Raleigh, NC 27609; (888) 901-5413; <u>www.flameoffcoatings.com</u>
  - 3. Hilti; 16721 Roscoe Blvd, North Hills, California 91343; (800) 879-8000; www.hilti.com
- B. Substitution Limitations: Subject to requirements of section 01 25 00 Substitution Procedures.

#### 2.2 MATERIALS

- A. Basis of Design shall be Contego Passive Fire Barrier Intumescent Latex Paint as manufactured by Contego International.
  - 1. Color: White
  - 2. VOC (Less Water): 0 Grams/Litre
  - 3. Weight/US Gallon: 10.8 lbs. (11.2 for HS Version)
  - 4. Hazardous Ingredient: N/A
  - 5. WHMIS Class: Not Controlled
  - 6. Flammability: Not Flammable

- 7. Weight Solids: 52.93 percent (62.45 for HS Version)
- 8. Volume Solids: 43.7 percent (68.3% for HS Version)
- 9. Specific Gravity: 1.29 (1.67 for HS Version)
- 10. pH Range: 8.0-8.5
- B. Testing Compliance:
  - 1. ANSI/UL723 Class A Doug Fir. (a=10 minutes, b=Extended to 30 minutes)
    - a. Results: Average Flame spread Index 0; Smoke Index 0, Class A
    - b. Results: Average Flame spread Index 0; Smoke Index 5, Class A
  - 2. ASTM E 119/UL-263/UBC 7.1, ANSI A2.1/ULC-S01/NFPA 251:
    - a. Results: Ranged from 103 to 121 minutes. STEEL "I" Beams Unrestrained
    - Steel Plate: ASTM 119 UL-263 ON .250 Plate 73 mil coating of Contego achieved 126 minutes (1000 degrees F, 538 degrees C unexposed surface) Unrestrained
    - Steel Beams and Decking With 4 Inches Concrete: ASTM 119 UL-263 with 58 mil coating of Contego achieved 87 minutes (1100 degrees F, 593 degrees C unexposed surface) Unrestrained, 174 minutes Restrained
    - d. 0.500 Steel Plate: ASTM E 119/UL-263/UBC 7.1, ANSI A2.1/ULC-S01/NFPA 251 Top Coated with 60 mils and Acrylic Enamel. The thermocouples exceeded an average of 1,200 degrees F (649 degrees C) at 2:21.50 proving that top coating adds 25% to 32% to the total fire resistance.
  - 3. NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room: Met all criteria.
- C. Primers and Top Coats: Refer to Section 09 91 00 for information on materials to be used when required by the Intumescent Coating manufacturer's installation instructions.
- PART 3 EXECUTION
- 3.1 EXAMINATION AND PREPARATION
  - A. If preparation is the responsibility of another installer, notify Architect of deviations from manufacturer's recommended installation tolerances and conditions.
  - B. Do not proceed with installation until substrates have been properly prepared and deviations from manufacturer's recommended tolerances are corrected. Prepare

surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Surfaces must be clean, dry, and free of any grease, oils or other contaminants. Previous layers of paint must be solidly adhered to the surface with no flaking, chipping, or cracks.

- 1. Remove hardware, hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
- 2. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- Cleaning: Before applying coatings or other surface treatments, clean substrates of substances that could impair bond of intumescent paint systems.
- 4. Schedule cleaning and painting application so dust and other contaminants will not fall on wet, newly painted surfaces.
- 5. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified. Coordinating shop-applied primers with finish coats is critical. If compatibility problems develop, it may be necessary to provide barrier coats over shop-applied primers or to remove primer and reprime substrate.
- C. Commencement of installation constitutes acceptance of conditions.

## 3.2 INSTALLATION

- A. Installation General: Install in accordance with Manufacturer's printed instructions.
  - 1. Product must be mixed thoroughly before application. Manufacturer recommends using a mixing paddle with power drill for a minimum of three 3 minutes at highest speed. Concentrate on bottom of bucket periodically moving to the middle and top areas.
  - 2. Product is properly mixed when:
    - a. There are no solids attached to the paddle after mixing at the bottom.
    - b. Paint shows a uniform consistency when mixed at the surface.
  - 3. Do not dilute or thin this product with any other liquid.
- B. Priming Requirements:
  - 1. Bare steel must always be primed with red oxide primer or manufacturer approved equivalent prior to applying the product.

- C. Application: Apply intumescent paints according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
  - 1. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable paint film.
  - 2. The Original formula (Type R, 50% solids) can be applied with a brush, roller, mitt or spray gun. The HS (High Solids) variant can only be applied with a spray gun.
  - 3. Spraying is the recommended method for either application. The recommended spray setup is 2400 psi (165 bar) with a 0.025 .032 inch tip (0.63 .813 mm). All Contego test applications are performed using a Graco XR5, but other commercial quality, positive displacement, airless spray guns are acceptable. If using the HS (High Solids) variant, use a spray gun with 3,600 psi with a 0.036 tip or bigger. In either case, spray a test patch to make sure the product is being properly atomized without clogging the nozzle or other parts of the spray gun.
  - 4. NEVER allow the intumescent coating to be exposed to rain, dew, snow, heavy settling fog, water spray or other forms or condensation until completely dry to protected with a suitable top coat. All exterior applications must be top coated. The intumescent finish must be protected until a suitable top coat has been applied and allowed to dry.
  - 5. Optimal application temperature is 75 degrees F (41 degrees C); application below 45 degrees F (25 degrees C) is not recommended.
  - 6. Provide finish coats that are compatible.
  - 7. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
  - 8. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.
- D. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
  - 1. Film thickness required is the same regardless of application method or whether applying Type R or HS.
  - 2. Do not apply succeeding coats until previous coats have dried completely as recommended by manufacturer. If sanding is required to produce a smooth, even surface, do so according to manufacturer's written instructions.
  - 3. If undercoats, stains, or other conditions show through the final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners,

crevices, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

- 4. Allow enough time between successive coats to permit complete drying. Drying time between coats depends on ambient temperature, humidity, and the thickness of the coat. Do not recoat surfaces until paint has dried thoroughly, not just dry to the touch. Applying additional coats of intumescent paint before existing coats have dried thoroughly can trap moisture under the surface film and cause the finish to loose adhesion or crack.
- E. Application Procedures: Apply coatings by brush, roller, spray, or other methods according to manufacturer's written instructions.
  - 1. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
  - 2. Prime Coat: Before applying intumescent paint on steel, apply a prime coat, as recommended by intumescent manufacturer, to substrates required to be painted that have not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas appears in the first coat.
  - Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate for surface to be coated. Provide total dry film thickness of entire system as recommended by manufacturer. This varies between different substrates and the kind of rating needed.
  - 4. Produce a smooth surface film using multiple coats. Provide a finish free of laps, runs, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
  - 5. Completed Work: Match approved samples for texture and coverage. Remove, refinish, or repaint work not complying with specified requirements.
- F. Coverage: Coverage varies depending on the thickness of the intumescent coating applied and that depends on the weight of the steel, whether or not it is restrained, whether or not it is top coated and the fire resistance rating needed. The dry thickness of each coat depends on the wet thickness applied. Structural steel requires between 5 and 170 dry mils, so multiple coats may be required as shown in our Hp/A regression tables for either version of the product being used. Generally, you can apply a maximum of 20 wet mils using our Type R before running the risk of sags or runs with the Regular Version and 35 mils with the HS version, but your actual maximum thickness also depends on ambient temperature and humidity. Keep in mind that it is difficult or impossible to lay down the maximum wet film thickness using a brush, roller, or mitt. To maximize your wet film thickness per pass, use a spray gun as discussed in this section.
- G. Structural Steel: A final dry film coating of 5 to 170 mil (0.25 to 4.32 mm) is recommended for adequate protection. The thickness needed depends on the W/D, Hp/A or A/P ratios of the steel being protected. Under proper conditions it is possible to achieve this with multiple coats of 20 mil (0.50 mm) wet (36 mils

wet for the HS Version). Under less than ideal conditions, it may be necessary to apply more at a lesser thickness until the total required dry film thickness is achieved. In all cases the next coat may be applied when the prior is completely dry.

- H. Top Coating: To add color or sheen to surfaces, the intumescent paint may be top coated using virtually any alkyd, or latex based acrylic enamel paint as soon as the intumescent coating is completely dry. To top coat with acrylic or latex, spray or roll initial color coat.
  - 1. If using a roller, do not try to re-roll or touch up until your initial color coat is dry.
  - 2. Failure to wait for the first color coat to dry will cause the first color coat to smear or back-roll off the surface.
  - 3. Once first color coat of latex/acrylic is dry apply second coat.
  - 4. Top coating does not reduce intumescent capability and, in fact, improves our fire resistance as discussed earlier.
- I. Tinting is possible, but to pastel shades only. Limit tint to 10 percent of paint volume. However, since top coating is both possible and recommended, use a top coat to achieve the exact color and sheen desired.
- 3.3 CLEANING AND PROTECTION
  - A. Cleanup: At the end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
    - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by proper methods. Be careful not to scratch or otherwise damage adjacent finished surfaces.
  - B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting, remove temporary protective wrappings provided by others to protect their work.
    - 1. After work of other trades is completed, touch up and restore damaged or defaced surfaces.
    - 2. Exterior applications must be protected by a tarp, tenting, or other method to avoid exposure to rain, dew, snow, condensation, heavy fog or other forms of accumulating moisture.

## END OF SECTION
# SECTION 09 97 13

# STEEL COATINGS

PART 1 – GENERAL

- 1.1 SECTION INCLUDES:
  - A. Surface preparation cleaners.
  - B. Exterior high performance paints and coatings systems for steel.
- 1.2 RELATED SECTIONS:
  - A. Section 02 41 19 Selective Building Demolition
  - B. Section 05 12 00 Structural Steel
  - C. Section 05 50 00 Metal Fabrications
  - D. Section 07 60 00 Flashing and Sheet Metal
  - E. Section 09 91 00 Painting
- 1.3 REFERENCES:
  - A. Safety Data Sheets: Per manufacturer's SDS for specific VOCs (calculated per 40 CFR 59.406). VOCs must meet the requirements of the local authority having jurisdiction.
  - B. South Coast Air Quality Management District (SCAQMD): Rule 1113 Architectural Coatings.
  - C. Green Seal, Inc.:
    - 1. GS-11 Standard for Paints and Coatings. (current edition)
    - 2. GC-03 Environmental Criteria for Anti-Corrosive Paints.
  - D. United States Green Building Council (USGBC): LEED-09 NC/CI/CS.
- 1.4 SUBMITTALS:
  - A. Submit under provisions of Section 01 33 23 Shop Drawings, Product Data and Samples
  - B. Product Data: For each paint system indicated, include:
    - 1. Product characteristics
    - 2. Surface preparation instructions and recommendations
    - 3. Primer requirements and finish specification

- 4. Storage and handling requirements and recommendations
- 5. Application methods
- 6. Cautions for storage, handling and installation
- C. Selection Samples: Submit a complete set of color chips that represent the full range of manufacturer's standard product colors.
- D. Verification Samples: For each finish product specified, submit samples (brushouts) that represent actual product, color, and sheen.
- E. Only submit complying products based on project requirements. One must also comply with the regulations regarding VOCs (CARB, OTC, SCAQMD, LADCO). To ensure compliance with regional regulations and other rules, businesses that perform coating activities should contact the authority having jurisdiction in the area where the coating will be used.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Paint exposed surfaces. If a color of finish or a surface is not specifically mentioned, Architect will select from standard products, colors, and sheens available.
- C. Do not paint prefinished items, concealed surfaces, operating parts, and labels unless indicated.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
  - 1. Product name and type (description)
  - 2. Application and use instructions
  - 3. Surface preparation
  - 4. VOC content
  - 5. Environmental handling
  - 6. Batch date
  - 7. Color number

- B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.
- D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

### 1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.8 WARRANTY

A. Warranty period for this work is extended to ten (10) years for materials; and workmanship against cracking or pealing for two (2) years.

### PART 2 – PRODUCTS

- 2.1 MANUFACTURERS
  - A. Materials for rust remediation:
    - 1. Rust-Oleum Krud Kutter, 11 Hawthorn Pkwy., Vernon Hills, IL 60061; phone: (800) 323-3584; www.rustoleum.com
    - 2. Rodda Paint Company Corroseal, 6107 North Marine Drive, Portland, OR 97203, phone: (800) 452-2315; www.corroseal.com
    - 3. Interstate Products, Inc. "1" Step; 6561 Palmer Park Circle Suite A, Sarasota, FL 34238; phone (800) 474-7294; www.interstateproducts.com
  - B. Materials for site galvanizing repair:
    - 1. Rust-Oleum Professional Galvanizing Spray, 11 Hawthorn Pkwy., Vernon Hills, IL 60061; phone: (800) 323-3584; <u>www.rustoleum.com</u>
    - ZRC Worldwide ZRC Cold Galvanizing Repair Compound spray; 145 Enterprise Drive, Marshfield, MA 02050-2132; phone: (800) 831.3275; www.zrcworldwide.com
  - C. Materials for new structural steel:
    - Dunn Edwards Corporation Aristoshield ASHL50; 4885 East 52ND Place, Los Angeles, California 90058-5507; phone (888) 337-2468; www.dunnedwards.com
    - 2. Benjamin Moore & Co. Corotech V540; 101 Paragon Drive, Montvale, NJ 07645; phone: (866) 708-9180; www.benjaminmoore.com

- D. Requests for substitutions will be considered in accordance with provisions of Section 01 25 10 Product Options and Substitutions.
- 2.2 APPLICATIONS/SCOPE
  - A. Surface preparation and cleaners
    - 1. Exterior surface preparation cleaners
  - B. Exterior high performance paints and coatings:
    - 1. Metal: aluminum, galvanized steel, and rusted steel/sheet metal.

# 2.3 SURFACE PREPARATION CLEANERS

- A. Exterior Cleaners:
  - 1. Krud Kutter Metal Etch by Rust-oleum (or equal): clean and prepare iron, steel, zinc, aluminum, and galvanized surfaces for painting. Removes rust, oil, grease, and dirt. Eliminates paint peeling, and other adhesion problems. Do not mix this product with any other chemicals.
  - 2. Krud Kutter Rustex by Rust-oleum (or equal): Rust inhibiting coating which converts rusted metal overnight into a rust retarding, paintable surface. When applied to rusted surfaces, iron oxide (rust) is chemically changed to iron phosphate, an inert, hard substance that turns the metal black. This increases the paint adhesion and durability of the coating.

#### 2.4 PAINT MATERIALS – GENERAL

- A. Paints and Coatings.
  - 1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
  - 2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufactures product instructions for optimal color conformance.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer. Prime rusted metal surfaces with a product specifically designed to convert existing rust into a metallic chemically inert surface. Prime galvanized surfaces with a primer designed to bond with galvanizing.
- C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.

D. Color: All sheet metal and steel not visible to the public from the ground shall be finished in a grey color. Sheet metal that is visible to the public from the ground shall be finished to match the building color scheme. Submit color brush-out of each color to be used.

# PART 3 – EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared; notify District Representative of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify District Representative of unsatisfactory preparation before proceeding.
- B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

### 3.2 SURFACE PREPARATION

- A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint, or other contamination to ensure good adhesion.
  - 1. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply the solution and scrub the mildewed area. Allow the solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry a minimum of 48 hours before painting. Do not add detergents or ammonia to the bleach/water solution.
  - 2. Remove items including but not limited to thermostats, electrical outlets, switch covers, and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
  - 3. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products.
- B. Galvanized Metal: Clean per 2.04 above.

### 3.3 INSTALLATION

- A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings only in accordance with manufacturer's recommendations.
- B. Do not apply to wet or damp surfaces.
- C. Apply coatings using methods recommended by manufacturer.

- D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.
- F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.
- G. Inspection: The coated surface must be inspected and approved by the District Representative just prior to the application of each coat.

### 3.4 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION

# SECTION 22 05 00

### PLUMBING AND UTILITIES

### PART 1 – GENERAL

#### 1.1 DESCRIPTION OF WORK:

- A. The requirements of the general conditions and Division 1 apply to all work hereunder; also, applicable provisions of Section 23 05 00 Mechanical Work General Requirements.
- B. Furnish and install all plumbing work indicated on the Drawings and described herein. Also, any incidental work not shown or specified necessary to provide the complete system.

#### 1.2 SERVICES:

- A. Make all arrangements for the utilities required. Pay all costs involved in obtaining the services, including gas service and meter, water meter and access box, street work, in lieu fees for sewer, etc.
- B. Verify the location of all services. No extra cost shall be allowed if services are not as shown.
- C. Determine storm and sanitary sewer elevation at point of connection before installing any sewer piping. Notify Architect immediately if indicated grades cannot be maintained.

#### 1.3 RECORD DRAWINGS:

A print of the plumbing plan showing underground piping will be furnished by the Contractor on which he shall indicate the locations of the underground installations as the work progresses. This shall be returned to Architect at completion of job.

#### PART 2 – PRODUCTS

- 2.1 PIPE AND FITTINGS OUTSIDE BUILDINGS:
  - A. See General Requirements Section for dielectric fittings and pipe corrosive protection. Connect to building services where terminated 5' outside footing line.

#### PART 3 – EXECUTION

- 3.1 RECORD DRAWINGS:
  - A. A print of the plumbing plan showing underground piping will be furnished to the Contractor on which he shall indicate the locations of the underground installations as the work progresses. This shall be returned to the Architect at completion of job.

# 3.2 PIPING CONNECTION:

A. Minimum grade on drain, vent, and waste piping shall be 1/4" per foot unless noted, or later approved. Vent piping shall be graded to a soil or waste line.

END OF SECTION

# SECTION 23 05 00

### MECHANICAL WORK - GENERAL REQUIREMENTS

### PART 1 – GENERAL

- 1.1 INCLUSIONS:
  - A. This section applies for all Division 21, 22, and 23 mechanical sections. All conditions and materials are pertinent to the other sections as if repeated in those sections.

### 1.2 DRAWINGS:

- A. Examine all Drawings prior to bidding of work and report any discrepancies in writing to the Architect.
- B. Drawings showing location of equipment, piping, ductwork, etc., are diagrammatic and job conditions will not always permit their installation in the location shown. The Mechanical Drawings show the general arrangement of all piping, ductwork, equipment, etc., and shall be followed as closely as existing conditions, actual building construction and the work of other trades will permit. The Architectural and Structural Drawings shall be considered a part of the work insofar as these Drawings furnish the Contractor with information relating to design and construction of the building. Architectural Drawings shall take precedence over Mechanical Drawings. Because of the small scale of the Mechanical Drawing, it is not possible to indicate all offsets. fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly providing such fittings, valves and accessories as may be required to meet conditions. When job conditions do not permit installation of equipment. piping, ductwork, etc., in the locations shown, it shall be brought to the Architect's attention immediately and the relocation determined in a joint conference. Contractor will be held responsible for the relocation of any items without first obtaining the Architect's approval. Contractor shall remove and relocate such items at his own expense if so directed by the Architect.
- C. Execute work mentioned in the Specifications and not shown on the Drawings, or vice versa, the same as if specifically mentioned in both.

# 1.3 CODES:

- A. Provide all work and materials in full accordance with the latest rules and regulations of the California Code of Regulations (CCR), Title 21, Title 22, and Title 24, as applicable, Safety Orders of the Division of Industrial Safety, (Cal OSHA); the California Electric Code; the California Plumbing Code; the California Building Code; California Mechanical Code; State Fire Marshal; and other applicable laws or regulations. Nothing in these plans or specifications is to be construed to permit work not conforming to these codes. Furnish without extra charge, any additional material and labor required to comply with these rules and regulations.
- B. Where material or equipment is specified to conform to standards such as

American Society of Testing and Materials (ASTM), Underwriters' Laboratories, Inc., (UL), American National Standards Institute (ANSI) and the like, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.

- 1.4 FEES AND PERMITS:
  - A. Procure and pay for all permits and licenses required.
- 1.5 FRAMING, CUTTING AND PATCHING:
  - A. Special framing, recesses, chases and backing for work of this section, unless specified otherwise, is covered under other sections. Be responsible for proper placement of all pipe sleeves, hangers and supports and location and sizing of openings for work of this section.
- 1.6 SUBSTITUTIONS AND MATERIAL LIST:
  - A. Product names are used as standards of quality, items furnished as standard on specified equipment shall be furnished on all substituted equipment at no extra cost to the contract regardless of disposition of submittal data; other materials or methods shall not be used unless approved in writing by the Architect. The burden of proof as to the equality of any proposed material shall be upon the Contractor; Architect's decision is final. Only one request for substitution shall be considered for each item. Equipment capacities specified are minimum acceptable. Submittals will not be accepted until compliance with the requirements of Contract Documents has been confirmed by the Contractor.
  - B. Unless stipulated otherwise in General Conditions and Division 1, submit a list of 7 copies of materials for approval within 35 days after the award of the Contract. It shall be accompanied by shop drawings, pump performance curves, fan curves, and other pertinent data, showing the size and capacity of the proposed materials. All materials to be used, whether substitutions or not, shall be listed in the order in which they appear in the specifications.
  - C. Any mechanical, electrical, structural or other changes required for the installation of any approved substituted equipment shall be made to the satisfaction of the Architect and without additional cost to the Owner. Approval by the Architect of the substituted equipment and/or dimensional drawings does not waive these requirements. Upon request, submit drawings of mechanical equipment spaces showing substituted equipment before installation.
  - D. Review of material shall not be construed as authorizing any deviations from the specifications unless the attention of the Architect has been directed to the specific deviations.
  - E. Furnish to the Project Representative, upon request, complete installation instructions on all materials and equipment before starting installation of same.
  - F. Submittals shall bear the specification reference or drawing location where they are specified. Submittals shall not be accepted in incomplete form. Submittals shall be organized into booklets for each specification section and submitted in indexed loose leaf binders with notation when it is a deviation from the

specifications.

- G. Have fire damper installation instructions available at the site during construction for use by the inspector.
- 1.7 SITE CONDITIONS:
  - A. Information on the drawings relative to existing conditions is approximate only. Deviations found necessary during progress of construction to conform to actual conditions, as approved by the Architect, shall be made without additional cost to the Owner. The Contractor shall be held responsible for any damage caused to existing services. Promptly notify the Architect if services are found which are not shown on drawings.

### 1.8 GUARANTEE:

- A. Repair or replace any defective work, materials or part which may appear within 1 year of the date of acceptance. This shall include damage by leaks.
- B. On failure to comply with the above guarantee within a reasonable length of time after notification is given, the Architect shall have the repairs made at the Contractor's expense.
- 1.9 MAINTENANCE AND OPERATING INSTRUCTIONS:
  - A. Instruct the Owner's authorized representatives in operation, adjustment and maintenance of all mechanical equipment and systems. Provide three copies of certificate signed by Owner's representatives attesting to their having been instructed.
  - B. Furnish three complete sets of operating and maintenance instructions bound in a hardback binder and indexed. Start compiling the data upon approval of list of materials. Final observation will not be made until booklets are approved by Architect.
  - C. These sets shall incorporate the following:
    - 1. Complete operating instructions for each item of heating, ventilating, air conditioning and plumbing equipment.
    - 2. Test data and air and water balancing reports as specified.
    - 3. Typewritten maintenance instructions for each item of equipment listing in detail the lubricant to be used, frequency of lubrication, inspections required, adjustment, etc.
    - 4. Manufacturer's bulletins with parts numbers, instructions, etc., for each item of equipment, properly stripped and assembled.
    - 5. Temperature control diagrams and literature.
    - 6. A complete list or schedule of all major valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify

each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed.

- 1.10 SCHEDULE OF WORK:
  - A. All temporary connections required to maintain services, including adequate heat and cooling, during the course of this Contract shall be made without additional cost to the Owner. The normal function of the building must not be interrupted; notify the Owner seven (7) days in advance before disturbing any service.
- 1.11 RECORD DRAWINGS:
  - A. Upon completion of the work and as a precedent to final payment, deliver to the Architect originals of all Drawings showing the work exactly as installed. Also deliver to the Architect one complete set of reproducibles of all Drawings showing the work exactly as installed. All Record Drawings shall be signed by the Contractor verifying their accuracy.

#### 1.12 DELIVERY AND STORAGE:

- A. All equipment, ducting and piping delivered to site shall be protected from the weather, humidity and temperature variations, dirt and dust and other contaminants.
- PART 2 PRODUCTS
- 2.1 GENERAL:
  - A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in good condition.
- 2.2 ELECTRIC MOTORS:
  - A. Shall be Allis-Chalmers, General Electric, Gould, Lincoln, or equal, selected for quiet operation. Furnish motors with splashproof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check electrical drawings. Provide a transformer for each motor not wound specifically for system voltage. The minimum efficiencies shall be as defined by IEEE 112 Test Method B and NEMA Standard MGI-112-53B.
- 2.3 MOTOR STARTERS:
  - A. Furnish starters with the proper size thermal overload units, ambient compensated. Provide 3-phase motor starters with 3-phase overloads. Magnetic starters shall have Hand-Off-Automatic switches and control transformers furnished integral with the starter when starter is serving an automatically controlled motor. Starters shall be Square D, Allen Bradley, or equal, in NEMA Type I enclosure inside and NEMA Type IIIR outside as required. Minimum starter size shall be 1.

### 2.4 VALVES AND FITTINGS:

- A. Valves: Shall be DeZurik, Crane, Nibco, Kennedy, or equal.
  - 1. Gate Valves thru 2-1/2" -- Crane #428, Kennedy #427, Nibco #T-595.
  - 2. Gate Valves 3" thru 4" -- Crane #460 or #461, Nibco #F-617.
  - 3. Gate Valves 5" and Larger --Demco NE, DeZurik #660 or Norris R3310 with throttling handle.
  - 4. Check Valves 2-1/2" and smaller -- Muessco #203BP, Crane #36, Nibco #T-413.
  - 5. Check Valves 3" and larger -- Muessco #105AP, Crane #373.
  - 6. Valves in copper lines shall be furnished with adapters, or may be solder joint type of equal quality to screw type valves.
  - 7. Ball Valves -- Worcester #411TS, Nibco #T-560, 2" maximum. On insulated piping provide Nibco CS extended lever handle. For natural gas and LPG provide Nibco T-585-70-UL, two piece, UL842 and CSA listed.
  - 8. Air Vent -- Armstrong #1AV where automatic type is shown. Install with shutoff valves or cocks and drain to a floor sink or drain. Provide Crane #250FF valve at 5'-0" maximum above floor for manual air vent at each high point of piping; pipe drain to floor sink or drain.
  - 9. Steam Traps -- Armstrong, Model 15 up to 15 psi; Model 30 up to 30 psi; Model 75 up to 75 psi; Model 125 above 75 psi.
  - Lift Fittings -- Webster Series 24, maximum height of each lift shall be 5'-0". Each lift shall have an inverted trap at the top, 2" minimum above connected return pipe.
  - 11. Flow Control Valves -- Bell & Gossett Circuit Setter Plus, Armstrong CBV, or equal thru 3", Circuit Sensor with hand valve above 3". Illinois Series 5000 will be acceptable thru 2".
  - Balance Valves -- Rockwell 142 thru 2", 143 above 2"; Walworth 1796 thru 2", 1797F-1718F above 2".
    Provide gate or globe valves on inlet of each water heater and inlet and outlet of each pump whether shown or not.
    Butterfly Valves: Keystone 100, Crane Monarch 2200 or equal.
- B. Unions and Flanges:
  - 1. Steel 2" and smaller -- 150# screwed black or galvanized malleable iron, match pipe, ground joint, brass-to-iron seat.
  - 2. Steel 2-1/2" and larger -- 150# black flange union, flat faced, full gasket.
  - 3. Copper or brass pipe or tubing 2" or smaller -- 150# cast bronze ground

joint, bronze-to-bronze seat with copper-to-copper end connections.

- 4. Copper or brass pipe or tubing 2-1/2" and larger -- 150# brass flange union, flat faced, full gasket.
- 5. Gaskets Hot and cold water -- Garlock Style 320D.
- 6. Flange Bolts -- Open-hearth bolt steel, square heads with cold pressed hexagonal nuts, cadmium plated in ground. Provide copper plated steel bolts and nuts or brass bolts and nuts for brass flanges.
- 2.5 PIPE HANGERS AND SUPPORTS:
  - A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the pipe hanger and supports as described in this specification.
  - B. References:
    - 1. MSS-SP58 manufacturers standardization society: pipe hangers and supports materials, design, and manufacture.
    - 2. MSS-SP69 manufacturers standardization society: pipe hangers and supports selection and application.
    - 3. NFPA 13 standard for the installation of sprinkler systems.
    - 4. ASTM A123 specification for zinc hot-galvanized coatings on products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strip.
    - 5. ASTM A653 g90 specification for steel sheet, zinc-coated by the hot-dip process.
    - 6. ASTM B633 specification for electrodeposited coatings of zinc on iron and steel.
  - C. Quality Assurance:
    - 1. Steel pipe hangers and supports shall have the manufacturers name, part number, and applicable size stamped in the part itself for identification.
    - 2. Hangers and supports shall be designed and manufactured in conformance with MSS-SP58.
    - 3. Supports for sprinkler piping shall be in conformance with NFPA 13.
  - D. Submittals:
    - 1. Submit product data on all hanger and support devices. Product data to include, but limited to materials, finishes, approvals, load ratings, and dimensional information.

- E. Acceptable Manufacturers:
  - 1. Manufacturer: subject to compliance with these specifications, pipe hanger and support systems shall be as manufactured by TOLCO, Inc., Superstrut, B-line, or equal.
- F. Pipe Hangers and Supports:
  - 1. Uninsulated pipes 2 inch and smaller:
    - a. Adjustable steel swivel ring (band type) hanger, TOLCO fig. 2, fig. 200.
    - b. Adjustable steel swivel j-hanger, TOLCO fig. 3.
    - c. Adjustable steel clevis hanger, TOLCO fig. 1, fig 1ld.
  - 2. Uninsulated pipes 2-1/2 inch and larger:
    - a. Adjustable steel clevis hanger TOLCO fig. 1.
    - b. Pipe roll with sockets, TOLCO fig. 322.
    - c. Adjustable steel yoke pipe roll, TOLCO fig. 324.
  - 3. Insulated pipe hot piping:
    - a. 2 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield, TOLCO fig. 1 with fig. 220.
    - b. 2-1/2 inch and larger pipes:
      - 1) adjustable steel yoke pipe roll with pipe covering protection saddle, TOLCO fig. 324 wit fig 260 thru 265.
      - 2) pipe roll with sockets with pipe covering protection saddle, TOLCO fig 322 with fig 260 thru 265.
  - 4. Insulated pipe cold piping:
    - a. 5 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield. TOLCO fig. 1 with fig. 220.
    - b. 6 inch and larger pipes:
      - 1) adjustable steel yoke pipe roll with pipe covering protection saddle. TOLCO fig. 322 with fig. 260 thru 265.
      - 2) pipe roll with sockets with pipe covering protection saddle, TOLCO fig. 322 with fig. 260 thru 265.
- G. Pipe Clamps: when flexibility in the hanger assembly is required due to horizontal movement, use pipe with weldless eye nuts, TOLCO fig. 4 or fig. 4h

with fig. 330. for insulated lines use bolted pipe clamps, TOLCO fig. 5 with fig.330.

- H. Multiple or Trapeze Hangers:
  - 1. Trapeze hangers shall be constructed from 12 gauge roll formed steel channel, 1-5/8" x 1-5/8" minimum, Tolstrut a12 strut or stronger as required.
  - 2. Mount pipes to strut channel trapeze with two piece pipe straps sized for outside diameter of pipe, Tolstrut fig. EMTC, rigid, O.D. or universal pipe clamps as required.
  - 3. For pipes subject to axial movement: strut mounted roller support, Tolstrut fig. Rol 12, 13, 14, 15 or 16 as required. Use pipe protection shield or saddles on insulated lines. TOLCO fig. 220 or fig. 260-265.
- I. Vertical Supports: steel riser clamp sized to fit outside diameter of pipe, TOLCO fig. 6.
- J. Copper Tubing Supports:
  - 1. Hangers shall be sized to fit copper tubing outside diameters.
    - a. Adjustable steel swivel band hanger, TOLCO fig. 202.
    - B. Malleable iron ring hanger, TOLCO fig. 301ct.
    - C. Adjustable steel clevis hanger, TOLCO fig. 81.
- K. Plastic pipe supports: adjustable band hanger, PVC coated with flared edges, TOLCO fig. 203, V-bottom clevis hanger with a "v" trough support, TOLCO fig. 1v and fig. 1vt to provide continuous support for flexible plastic pipe.
- L. Supplementary structural supports: design and fabricate supports using structural quality steel bolted framing materials as manufactured by TOLCO, inc. Channels shall be roll formed, 12 gauge steel, 1-5/8" x 1-5/8" or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the strut system.
- M. Upper Attachments:
  - 1. Beam Clamps:
    - a. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
    - b. C-clamps shall have locknuts and cup point set screws, TOLCO fig. 64. Reversible top or bottom flange c-clamps shall be used when attaching a hanger rod to the top of flange of structural shapes, TOLCO fig. 65 and fig. 66. Retaining straps shall be used

to maintain the clamps position on the beam where required.

- c. Center loaded beam clamps shall be used where specified. Steel clamps shall be TOLCO fig. 62. Malleable iron or forged steel beam clamps with cross bolt shall be TOLCO fig. 329.
- 2. Concrete Inserts:
  - a. Cast in place spot concrete inserts shall be used where applicable, either steel or malleable iron body, TOLCO fig. 310 or fig. 309. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, TOLCO fig. 310n or fig. 309n.
  - b. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge steel, complete with styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs./ft. In concrete, Tolstrut fig. B-12 conct.
- N. Accessories:
  - 1. Hanger rods shall be threaded both ends, or continuous threaded rods of circular cross section TOLCO fig. 100 or fig. 103. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
  - 2. Shields shall be 180° galvanized sheet metal, 12 inch minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, TOLCO fig. 220.
- O. Outdoor Area Finishes:
  - 1. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized. Zinc plated hardware is not acceptable for outdoor or corrosive use.
- Q. Wood Connectors: Angle clips with through bolts in shear; no lag screws in tension.
- 2.6 SERVICE MARKERS:
  - A. 4" round by 30" long concrete marker, Haley Mfg., Co., Pinkerton, or equal with engraved brass identification plate.
- 2.7 PIPE PROTECTION:
  - A. Polyethylene Coating: Extruded polyethylene coating, X-Tru-Coat, or field wrap as in B, Raychem "Thermofit" polyethylene sleeve joints, or field wrap as in B.
  - B. Tape Wrap: Pressure sensitive polyvinyl chloride tape, "Trantex #V-10 or V-20", "Scotchrap #50", Slipknot 100, or equal, with continuous identification. Tape

shall be a minimum of 20 mils thick for fittings and irregular surfaces, 2 wraps, 50% overlap, 40 mils total thickness. Tape shall be laminated with a suitable adhesive. Widths as recommended by the manufacturer for the pipe size. Wrap 50'-0" or longer sections of piping with an approved wrapping machine.

- C. Pabco Wrap: Pabco Specifications #D-40-240K double wrap, in accordance with manufacturer's recommendations or PVC as in B. Lap pipe wrap a minimum of 1/4" and stagger the second layer. All Pabco pipe wrapping shall be done by the manufacturer's agent and not by the Contractor, except the field joints.
- D. Field Joints and Fittings: Pabco double wrap and Polyvinyl Chloride type as above. Provide at least 2 thicknesses of tape over the joint and extend a minimum of 4" over adjacent pipe covering. Build up with primer to match adjacent covering thickness. Width of tape on fittings shall not exceed 2". Tape shall adhere tightly to all surfaces of the fittings, without air pockets.

# 2.8 ACCESS DOORS:

Milcor, Newman, or equal, with concealed hinges, screwdriver locks, prime coated with rust inhibitive paint, and style of door to suit ceiling or wall construction. Access doors in acoustical tile ceilings shall be "Sesame" with tile recess. Doors shall be 14 gage C.R. steel and shall be 22" x 30", 24" x 24" in tile ceiling, unless otherwise noted or required, fire rated to match rating of surface in which installed. Doors in walls of toilet rooms, shall be stainless steel.

#### 2.9 THERMOMETERS:

- A. Weston, Ashcroft, Rochester, or equal, 5" diameter bimetal dial, adjustable from face, located to be easily read from normal personnel approach. Normal reading shall be at mid-scale.
- B. Provide extension for insulation.
- C. Provide thermometers with steel bulb chambers and brass separable sockets.
- D. Thermometers for air temperature shall have minimum 8" stem.

#### 2.10 GAGES:

- March "Quality Gage", U.S. Gage, Ashcroft, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2" dial face. Normal reading shall be at mid-scale. Provide a gage cock on each gage connection.
- B. Supply gages on inlet and outlet of each pump and where shown on the drawings.
- C. Supply a Pete's Plug test plug or equal where shown on the drawings, nordel core.

#### 2.11 STRAINERS:

Charles M. Bailey #100A, Armstrong, Muessco Fig. 11, or equal, "Y" pattern, 125 psi

W.P. minimum, with monel screens with 20 square mesh for 2" and smaller and 3/64" perforations for 2-1/2" and larger. Install all strainers with a blow off hose valve with hose adaptor. Strainer shall have gasketed cover with straight thread.

- 2.12 INSULATION:
  - A. Refer to Part 3.

### 2.13 FLEXIBLE CONNECTIONS:

- A. Furnish and install Thermo Tech., Inc., F/J/R, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, except fan and coil units, on each connection to each base-mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
- B. Flexible connections in refrigerant lines: Flexonic, Anaconda, or equal, metal hose, full size.
- C. Anchor piping securely on the system side of each flexible connection.

### PART 3 – EXECUTION

- 3.1 ELECTRICAL REQUIREMENTS:
  - A. Provide adequate working space around electrical equipment in compliance with the California Electric Code. Coordinate Mechanical Work with Electrical Work to comply.
  - B. Furnish and set in place all motors. Furnish necessary control diagrams and instructions for controls. Before permitting operation of any equipment which is furnished, installed or modified under this section, review all associated electrical work including overload protection devices and assume complete responsibility for correctness of electrical connections and protective devices.
  - C. Motors and control equipment shall conform to Standards of National Electrical Manufacturer's Association. All equipment and connections exposed to the weather shall be NEMA IIIR with factory wired strip heaters in each starter enclosure, and temperature control panel to inhibit condensation.
  - D. All power wiring, conduit, fuses, thermal overloads, and disconnect switches, and connection of all motors are under electrical work, Division 16. All wiring and conduit associated with the temperature control and indicating system is included in this section. Run all wiring in conduit in accordance with Division 16.
  - E. Electric Motors: All motors shall be rated for continuous operation at 115% of nameplate amperage throughout the entire operating cycle. Motors found exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepowers shown are minimum and shall be increased as necessary to comply with above requirements.
  - F. Motor Starters: Furnish magnetic motor starter for all equipment furnished under this section except those shown in motor control centers.

G. Provide OSHA label indicating device starts automatically.

# 3.2 PRIMING AND PAINTING:

- A. Perform all priming and painting on the equipment and materials as specified herein.
- B. Priming: Exposed ferrous metals, including piping, which are not galvanized or factory finished shall be primed. Black steel pipe exposed to the weather shall be painted one coat of Rust-Oleum #769 primer and one coat of #960 primer. Items to be primed shall be properly cleaned by effective means, free of rust, dirt, scale, grease, wax and other deleterious matter. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
- C. Finish Painting:
  - 1. Equipment and machinery located in fan rooms, equipment rooms and similar purpose rooms and at other locations when specified, shall be furnished with a standard factory-applied beaked enamel finish in approved uniform colors. At the Contractor's option, equipment and machinery may be field-painted hereunder with two coats consisting of an air-dried synthetic industrial enamel undercoater and enamel as approved over the shop or factory-applied primer. All exposed ferrous metals, including piping located in fan rooms, equipment rooms, and boiler rooms shall be painted one coat of an approved paint, of color selected, over the primer. Canvas insulation jackets, including piping located in fan rooms, equipment rooms, and boiler rooms shall be painted two coats of paint of color selected. Mechanical Work, except as described herein, occurring in rooms or spaces required to be painted on walls, and/or ceilings will be finish painted as described above for equipment and machinery in equipment rooms.
- D. See Painting Section for detail requirements and finishes.

# 3.3 INSTALLATION OF PIPING SYSTEMS:

- A. General:
  - 1. All piping shall be concealed unless shown or otherwise directed.
  - 2. Where piping or conduit is left exposed within a room, the same shall be run true to plumb, horizontal or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor or ceiling surfaces.
  - 3. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-8" without written approval from the Architect.
  - 4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no

additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.

- 5. Grade all water-circulating piping, flow and return, to provide for drainage of lines and elimination of air.
- 6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
- 7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
- 8. Pipe the discharge of each relief valve, air vent, backflow preventer and similar device to floor sink or drain.
- 9. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
- B. Sleeves: Install AMI sleeves of sufficient size to allow for free motion of pipe, 24 gage galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside wall above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made water-tight. At Contractor's option pipes through slabs on grade may be wrapped with 1" thick fiberglass insulation to completely isolate the pipe from the concrete in lieu of sleeves. Link seal casings may be used in lieu of caulking.
- C. Flashing: Furnish and install around each pipe, where it passes through a roof, a flashing and counterflashing.
- D. Pipe Hangers and Supports:
  - 1. Pipe shall be adequately supported by pipe hanger and supports specified in part 2 products. Hangers for insulated pipes shall be sized to accommodate insulation thickness.
  - 2. Horizontal steel piping shall be supported in accordance with MSS SP-69 tables 3 and 4, excerpts of which follow below:

Nominal Pipe Size	Rod Diameter	Maximum Spacing
1/2 - 1-1/4	3/8	7' 0"
1-1/2	3/8	9' 0"
2	3/8	10' 0"
2-1/2	1/2	11' 0"
3	1/2	12' 0"
3-1/2	1/2	12' 0"
4	5/8	12' 0"
5	5/8	12' 0"
6	3/4	12' 0"
8	3/4	12' 0"

10	7/8	12' 0"
12	7/8	12' 0"
14	1	12' 0"
16	1	12' 0"

3. Horizontal copper tubing shall be supported in accordance with mss sp-69 tables 3 and 4, excepts of which follow below:

Nominal Pipe Size	Rod Diameter	Maximum Spacing
1/2 -3/4	3/8	5' 0"
1	3/8	6' 0"
1-1/4	3/8	6' 0"
1-1/2	3/8	6' 0"
2	3/8	8' 0"
2-1/2	1/2	9' 0"
3	1/2	10' 0"
3-1/2	1/2	11' 0"
4	1/2	12' 0"
5	1/2	12' 0"
6	5/8	12' 0"
8	3/4	12' 0"

- 4. Provide means of preventing dissimilar metal contact such as plastic hangers, felt lined hangers, copper colored epoxy paint, or non adhesive isolation tape. Galvanized felt isolators sized for copper tubing may also be used, TOLCO fig. 83.
- 5. Support horizontal cast iron adjacent to each hub, with 5 feet maximum spacing between hangers.
- 6. Install hangers to provide a minimum of  $\frac{1}{2}$  inch space between finished covering and adjacent work.
- 7. Place a hanger within 12 inches of each horizontal elbow.
- 8. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- 9. Do not support piping from other pipes, ductwork or other equipment which is not building structure.
- 10. Burning or welding on any structural member may only be done if approved by the architect.
- 11. Insulate copper tubing from ferrous materials and hangers with 2 layers of 3" wide 10 mil polyvinyl tape wrapped around pipe.
- 12. No valve or piece of equipment shall be used to support the weight of any

pipe.

- 13. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical.
- 14. Concrete inserts:
  - a. Provide inserts for placement in formwork before concrete is poured.
  - b. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - c. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch.
- 15. On insulated pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Provide rigid insulation and a 12" long, 18 gage galvanized sheet iron shield between the hanger whenever hangers are installed on the outside of the pipe covering.
- 16. Burning or welding on any structural member may only be done if approved by the Architect.
- 17. Insulate copper tubing from ferrous materials and hangers with 2" thickness of 3" wide 10 mil polyvinyl tape wrapped around pipe.
- 18. No valve or piece of equipment shall be used to support the weight of any pipe.
- 19. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical.
- E. Anchors:
  - 1. Piping subject to expansion or contraction shall be provided with anchors and expansion loops or joints as required. Provide adequate guides to prevent misalignment.
- F. Fireproofing:
  - 1. The annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors and walls shall be protected by a UL-listed Fire Stopping System, 3M, Fire Barrier, Dow Firestop or Nelson Firestop.
- 3.4 PIPE JOINTS AND CONNECTIONS:
  - A. Cutting: Cut piping and tubing square, ream cut ends to full bore, remove rough edges, burrs, loose materials.
  - B. Threaded Pipe: Make joints with Rectorseal #5 or Permatex #1 thread lubricant or joint tape. Use no caulking of any kind. Remake leaky joints with new

materials.

- C. Copper and Brass Pipe and Tubing (except Control Piping): Make all joints with silver brazing alloy, Sil-Fos or equal, 1100 degrees F. melting point or greater, ASTM B-260, except that water piping 1-1/4" and smaller not buried in the ground or concrete and Type DWV plumbing piping may be made up with 95-5 tin-antimony, ASTM B-32, Grade 5A solder. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed. Use leadless solder for potable water piping.
- D. Welded Pipe:
  - 1. Make up with oxyacetylene or electric arc process.
  - 2. All welding shall conform to the American Standard Code for Pressure Piping ASA B-31, Section 6, Chapter 4, and Appendix A. When requested by the Architect, furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.
  - 3. All line welds shall be of the single "V" butt type. Welds for flanges shall be of fillet type.
  - 4. Where the branch is 2 pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

# 3.5 UNIONS AND FLANGES:

- A. Install Epco, or equal, dielectric unions or flanges at points of connection between copper or brass piping material and steel or cast iron pipe or material except in drain, waste, vent, or rainwater piping. Bushings or couplings shall not be used. Dielectric unions shall not be installed below grade.
- B. Install unions, whether shown or not, at each connection to all equipment and tanks, at one connection to each valve or cock, and at all connections to all automatic valves, such as temperature control valves.
- C. Locate the unions for easy removal of the equipment, tank or valve.

# 3.6 ACCESS DOORS:

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical system; for example, at concealed valves, strainer, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.
- 3.07 INSULATION WORK:
  - A. General:
    - 1. All insulation shall be done by a contractor specifically licensed for insulation work. Insulation applied by the mechanical and plumbing

contractor is not acceptable.

- 2. The term "piping" used herein shall include pipe, air separators, valves, strainers and fittings. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible. Valve and fitting covers may be preformed PVC. Provide rigid insulation, 18" minimum length at each pipe hanger. Seal ends of insulation with jacket.
- 3. Do not insulate flanges and unions on high temperature piping. Insulate unions and pump bodies on chilled water and combination hot and chilled water systems with three heavy layers of Mortell's No-Drip Paint, 1/16" minimum total thickness or Armstrong Armaflex Tape per manufacturer's recommendations.
- 4. Clean thoroughly, test, and have approved, all piping and equipment before installing covering.
- 5. All insulation, adhesive coverings and jackets including pre-insulated flexible ductwork shall have a flame spread of 25 or less and developed smoke rating of 50 or less tested in accordance with ASTM E84.
- B. Insulation of Piping:
  - Insulate all heating and domestic hot and tempered water supply and return, low pressure steam supply, steam vent, boiler feed water, and low and high pressure steam return, including pumped return piping with 3-1/2# per cubic foot minimum density fiberglass with ASJ-SSL jacket, or equal; 1" thick for pipes 1" and smaller; 1-1/2" thick for pipes 1-1/4" thru 4"; and 2" thick for pipes 5" and over. High and medium pressure steam piping shall be insulated same as above, except 1-1/2" thick for piping 1" and less; 2-1/2" thick for 1-1/4" thru 4"; 3-1/2" and 5" and larger. Domestic hot and tempered water shall be insulated with 1" thick 3-1/2# density fiberglass with ASJ-SSL jacket.
  - 2. Insulate all refrigerant suction piping, chilled water supply and return piping and all combination hot and chilled water piping with 1" thick, 3-1/2# per cubic foot minimum density fiberglass with factory-applied ASJ-SSL jacket, or equal, 1-1/2" thick for chilled water pipes 6" and over and refrigerant piping 1-1/4" and larger. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of Glasfab saturated in Foster's 30-36, 3M, or equal, carried 3" over the adjoining pipe insulation. Finish with a coat of Foster's 30-36, 3M, or equal. The 3" wide SSL end laps furnished with the insulation shall be adhered over the end joints. Seal entire surface of insulation vaportight, including joints and ends of plastic fitting covers.
  - 3. Urethane insulation will not be allowed above ground or on hot water or steam piping.
  - 4. On all insulated piping exposed to the weather apply .015 aluminum jacket secured with 1/2" aluminum bands on 12" centers. Cover fittings

with Prefabricated aluminum jacket fittings or custom fabricated fittings designed to provide water shedding. Insulation shall be vaportight before applying metal jacket. Seal and caulk all joints and screw penetrations that have a potential for moisture intrusion.

Refrigerant line sets line sets exposed to the weather shall be covered with Venture Tape 1507, 3 mil, UV protectant.

- C. Duct Insulation:
  - 1. Wrap all unlined concealed supply and return ducts with O.C. Fiberglas All-Service duct wrap with a reinforced foil Kraft vapor barrier facing 2" thick and 3/4# per cubic foot density. Wrap insulation entirely around duct and wire securely in place with #16 wire 12" o.c. and each side of each standing seam and over each insulation joint. Lap all insulation joints 3" minimum. Insulate ducts installed tight against other work before hanging in place.
  - 2. All ducts and plenums in Fan Room shall be insulated with 1-1/2" (2" outside building) thick Fiberglas 705 insulating board with factory-applied foil facing. Insulation shall be adhered to ducts with Type B STICKLIPS at 18" o.c. cemented in place. Wrap insulation with 8 ounce canvas sized with Foster's Seal-fas mastic. Apply one final undiluted coating of Foster's 30-76 white insulation coating.
  - 3. Seal airtight seams of all ductwork with **Hardcast Foilgrip 1402 181 BFX** indoor/outdoor roll sealant. Sealant shall be provided in 3" wide rolls. Sealant shall be UL 181 listed, 2 mil thick aluminum with 12 mil elastomeric modified butyl rubber. Flamespread index 0, Smoke Developed rating 0. Overlap ends of sealant. After applying to duct rub down with adequate pressure to assure complete contact. Seal insulated ducts before insulating
  - 4. Seal airtight all joints and seams with Design Polymerics 1020 water based duct indoor/outdoor sealant (UL 181 B-M listed). Sealing shall including but not be limited to fitting joints, TDC/TDF flange corners, sheet metal screw heads, all seams not sealed with foilgrip roll sealant, flexible duct connections, round collars. Apply sealant liberally by brush, trowel, pump, or caulk to achieve a maximum leakage amount of 1% in accordance with SMACNA. For fittings and couplings: apply sealant to male sections of fitting, apply sheet metal screws per SMACNA requirements, and apply a 2 inch band of sealant around outside of Joint covering all screws. For flexible duct, apply sealant between the ends of the duct and the collar in a 2 inch band. Provide duct worm gear band over connection to collar in accordance with other sections of this specification.

# 3.8 EQUIPMENT IDENTIFICATION:

A. Identify each piece of equipment with an engraved brass tag fastened with screws. For example - EXHAUST FAN 2.

# 3.9 PIPE IDENTIFICATION:

- A. Identify each piping system and indicate the direction of flow by means of Idento Bands (Idento Metal Products Co.) or SETMARK pipe markers. Apply the markings after all painting and cleaning of the piping and insulation is completed.
- B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction; and at approximately 50'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.
- D. The legends and flow arrows shall conform to ANSI A13.1.
- E. The sizes of the letter and flow arrows shall be as follows:

Outside Diameter of Pipe or Covering (Inclusive)	Minimum Length Size of Letter	of Flow Arrow
5/8" to 2"	1/2"	2-1/2"
2-1/2" and Larger	1"	4"

- F. Each hand valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in one-quarter inch (1/4") high letters.
- 3.10 GUARDS:
  - A. General: Belt drive, gear drive shafts, couplings, fan inlets and outlets, and running equipment shall be properly protected by guards as required by the CCR, Title 8, Division of Industrial Safety, Sub Chapter 7, General Industry Safety Orders, Articles 31 through 36, whether shown on the drawings or not.
  - B. Construction: Guards shall be factory furnished or made of expanded metal with angle iron framework. Guards for belt drives shall have an easily removable section for replacement of belts. Openings shall be provided at shaft ends for taking rpm readings.

# 3.11 ANTI-VIBRATION BASES AND HANGERS:

- A. All ventilating and air conditioning equipment shall operate under continuous demand without objectionable vibration. Contractor shall be sure that above result is achieved. Isolate all equipment connections, including conduit, piping, drains, etc.
- B. Air conditioning units and all fans shall be supported on anti-vibration bases or hangers. Other equipment and pumps shall be supported on anti-vibration bases, pads or hangers, when shown on Drawings or specified with equipment. Isolators and supporting bases shall be supplied by single manufacturer,

Kinetics, Korfund, or equal. Type of mounting and supporting base for each piece of equipment shall be as tabulated on equipment schedule or as hereinafter specified. Individual mounts shall be Kinetics Type FPS, or equal. Contractor shall provide calculations for isolators and mounting acceptable to reviewing authority.

- C. All piping in Mechanical Equipment Rooms and piping three supports away from mechanical equipment mounted on vibration isolators shall be isolated from structure by means of vibration and noise isolators. Suspended piping shall be isolated with combination Spring and Fiberglass hangers in supporting rods. Hangers shall be Type H. Floor-mounted piping shall be supported directly on Spring Mounts, Type S. Vertical pipe risers shall be isolated from structure by means of vibration and noise isolating Expansion Hangers, Type XH.
- D. Isolator manufacturer's submittal shall include complete design for supplementary bases, tabulation of design data on isolators, including O.D. free operating, and solid heights of springs, free and operating heights of neoprene or fiberglass isolators, and isolation efficiency based on lowest operating speed of equipment supported.

# 3.12 SPECIAL SEISMIC REQUIREMENTS:

A. Supports for all piping and ductwork shall be in accordance with SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems". Office of Statewide Health Planning and Development approved anchorage No. R-0010. Contractor shall provide calculations for isolators and mounting acceptable to the reviewing authority.

# 3.13 TESTS AND ADJUSTMENTS:

- A. Test the installation in accordance with the following requirements and all applicable codes. Notify the Architect at least 7 days in advance of any test. All piping shall be tested at completion of roughing-in, or at other times as directed by the Architect.
- B. Furnish all necessary materials, test pumps, gases, instruments and labor required for testing. Tests shall be witnessed by the Architect.
- C. Isolate from the system all equipment which may be damaged by test pressure.
- D. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.

System Tested	Test Pressure PSI	<u>Test With</u>
All Hot, Chilled Water Piping	125	Water
Up to 15 psi Steam Piping and		
All Steam Condensate Piping	150	Water
Steam Piping above 15 psi	300	Water

All steam piping shall be tested with normal pressure steam before insulating.

E. Testing, Evacuating, Charging and Lubrication of Refrigeration Systems:

- Pressurize with dry nitrogen and/or refrigerant to 300 psig and test all joints with an electronic detector or halide torch. Release the pressure and attach a high vacuum pump. Evacuate to 4mm (4000 microns) and hold for 30 minutes. Break to 5 psig with dry nitrogen or R-22 and allow to remain in the system for ten minutes. Evacuate to 2mm (2000 microns) and hold for 30 minutes. Use a mercury manometer or electronic vacuum gauge. Do not start timing until recommended vacuum range is reached.
- 2. At the end of the evacuation, if the system has been proved leakfree, charge with refrigerant and fill the crankcase to the oil level specified by the manufacturer. All refrigerant oil shall be delivered to the location in sealed containers.
- 3. Replenish for a period of one year without cost to the Owner all refrigerant and oil required to maintain the proper levels.
- F. Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with all fixtures and other appliances connected.
- G. Should any material or work fail in any of these tests, it shall be immediately removed and replaced by new material, any portion of the work replaced shall again be tested by Contractor at his own expense.
- H. Instruct Owner's operating personnel during test and operating adjustment period. Lubricate each item of equipment, including motors, before operation.

END OF SECTION

# SECTION 23 05 10

### HEATING, VENTILATING AND AIR CONDITIONING

#### PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS:

- A. The requirements of the General Conditions and Division 01 apply to all work hereunder, also applicable provisions of Section 23 05 00 MECHANICAL WORK - General Requirements.
- B. Drawings and general provisions of the Contract, including general and supplementary conditions apply to the work of this Section.

#### 1.2 DESCRIPTION OF WORK:

A. Furnish and install all heating, ventilating and air conditioning work indicated on the drawings and described herein. Also any incidental work not shown or specified that is necessary to provide the complete system.

### 1.3 COORDINATED LAYOUTS:

- A. Contractor shall provide 1/4" equals one foot scaled coordination drawings showing plan and pertinent section views of all piping, ductwork and electrical systems. Drawings shall be on bond and the work represented shall be fully coordinated with the structure, other disciplines, and with all finishes. Since scale of contract drawings is small and all offsets and fittings are not shown, contractor shall make allowances in bid for additional coordinated installation. If changes in duct size are required, equivalent area shall be maintained and the aspect ratio shall not be in excess of 2 to 1 unless approved by the engineer. Drawings shall be submitted for review prior to fabrication and installation. Drawings may be submitted in packages representing at least 1/4 of the building ductwork.
- B. Check routing on all ductwork before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to above.
- C. It shall be responsibility of Heating, Ventilating and Air Conditioning Contractor to coordinate the other mechanical and electrical trades so that complete job is neat and in conformity with plans and specifications.

#### 1.4 PLUMBING:

A. All plumbing work required in the course of this contract shall be performed in strict accordance with all codes and regulations. Plumbing work done under this contract shall not adversely affect the operation of the existing plumbing systems. All materials shall be new and shall match existing.

# PART 2 – PRODUCTS (OR MATERIALS)

- 2.1 PIPE AND FITTINGS:
  - A. See General Requirements section for dielectric fittings and pipe protection.
  - B. Hot Water, Chilled Water, and up to 15 psi Steam Piping Above Slab or Ground: Schedule 40 black steel pipe, ASTM A-53. Fittings shall be Nibco standard butt welding type conforming to ANSI Specification B16.28; except that fittings 2" and smaller and local exposed connections to equipment may be 150 psi malleable screwed fittings. Changes in size of steam piping shall be made with eccentric fittings.
  - C. Air Vent Discharge Piping: Type L hard copper tubing with wrought copper fittings.
  - D. Condensate Drain Piping: Type DWV copper tubing and fittings or Schedule 40 galvanized steel pipe and cast iron drain or vent fittings.
  - E. Steam Piping Above 15 PSI: Schedule 40 black steel pipe with Schedule 40 welded fittings, Tube Forgings, conforming to ANSI Specification B16.9, latest standard. All changes in size shall be made with eccentric fittings.
  - F. Steam Condensate Return Piping including Pumped Return and Steam Vent Piping: Type K hard copper tubing with wrought copper solder-type fittings, with eccentric reducers, except that exposed piping in the boiler room shall be Schedule 80 black steel pipe and Schedule 80 welding fittings.
  - G. Blow Off and Relief Valve Discharge Piping: Schedule 40 galvanized steel pipe and galvanized malleable fittings.
- 2.2 FANS:
  - A. All fans AMCA labeled with self-aligning, enclosed ball bearings, accessible for lubrication, unless specified otherwise.
  - B. Roof Mounted:
    - 1. Provide bird guard and disconnect switch.
    - 2. Fan wheels shall be centrifugal, non-overloading, all aluminum.
    - 3. Curb cap and orifice inlet shall be one piece aluminum.
    - 4. Shaft and motor bearings shall be relubricable ball bearings for belt-drive.
    - 5. Wheel configuration shall be as scheduled on the drawings.
    - 8. Provide ventilated curb for kitchen exhaust fans.
- 2.3 FAN DRIVES:
  - A. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives 2 times, the name plate rating of the motor with proper

HEATING, VENTILATING AND AIR CONDITIONING

allowances for sheave diameters, speed ratio, arcs of contact and belt length.

- 1. All drives shall be variable speed, Dayco, Browning or Woods. Allow for replacement of fan drive and belt as required to suite the balance requirements of the project.
- 2. All drives for 5 horsepower motors and larger shall have a minimum of 2 belts.
- 3. Belts shall be within 1 degree 30 minutes of true alignment in all cases.
- 4. All variable speed drives shall be selected to allow an increase or decrease of minimum of 10% of design fan speed.
- 5. Motors of 25 HP and less shall have adjustable pitch sheaves; sheaves on motors above 25 HP may be non-adjustable. Change, at no extra cost to Owner, the non-adjustable sheaves to obtain desired air quantities.
- B. Sheaves: Sheaves shall be cast or fabricated, bored to size or bushed with fully split tapered bushings to fit properly on the shafts. All sheaves shall be secured with keys and set screws.
- C. Belts: All belts shall be furnished in matched sets.

### 2.4 DAMPERS:

- A. Manual Air and Balance Dampers: Ruskin CD35, opposed blade.
- 2.5 DUCTWORK:
  - A. Galvanized Sheet Metal, See Part 3.
- 2.6 VIBRATION ELIMINATOR RAILS:
  - A. Provide Kinetics or equal vibration eliminator rails as specified on the drawings.
- PART 3 EXECUTION
- 3.1 EQUIPMENT START-UP:
  - A. Initial start-up of supply, exhaust and return fan systems and pumps shall be under the direct supervision of the Testing and Balancing Contractor.
- 3.2 PIPING:
  - A. Refrigerant Piping: Extreme care shall be taken to keep the entire system clean and dry during installation. All lines shall be straight and free from kinks, restrictions or traps; horizontal suction lines shall be sloped toward compressor, 1" to 10'. For pre-fab line sets, all tubing shall be evacuated and sealed at the factory. The seal must not be broken until ready for assembly. If there is any evidence of dust, moisture, or corrosion, the tubing must be cleaned out by drawing a swab soaked with methyl alcohol through the tubing as many times as necessary to thoroughly clean the tubing.

- B. All piping under suspended floors shall be kept 6" minimum above ground; excavate as necessary.
- 3.3 EXPANSION JOINTS:
  - A. Furnish and install expansion loops or joints in the steam or water lines as required with anchors and guides as required for the proper operation of the expansion loops or joints.
- 3.4 SHEET METAL WORK:
  - A. Construct and install all sheet metal in accordance with latest SMACNA recommendations for 2" static pressure. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances, as approved by the Architect, at no extra cost to Owner.
  - B. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing on inside of duct. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.
    - 1. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers.
    - 2. All ductwork, adhesives, lining, sealants, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with ASTM E84.
  - C. Round ducts with equivalent effective cross sectional area as determined by ASHRAE Guide, latest edition, may be used in lieu of concealed rectangular ducts shown, space permitting. Round and oval sheet metal ducts shall be spiral lock seam or longitudinal construction seam construction. Fittings shall be continuous weld or spot weld and seal. United Sheet Metal, SEMCO, or equal.
  - D. The throat radius of all bends shall be 1-1/2 times the width of the duct wherever possible and in no case shall the throat radius be less than one width of the branch duct. Provide square elbows with Titus or HEP double thickness turning vanes where space does not permit the above radius, or where square elbows are shown.
  - E. The slopes of transitions shall be approximately one to five unless shown otherwise, and no abrupt changes or offsets of any kind in the duct system shall be permitted.
  - F. Provide sheet metal angle frame at all duct penetrations to wall, floor, or ceiling. Seal ductwork watertight at equipment room floor.
  - G. Exposed round ducts shall be United Sheet Metal spiral duct and fittings, 22 gauge minimum for duct, 20 gauge minimum for fittings. Assemble with duct sealer and sheet metal screws.
  - H. Provide Ventlon flexible connections on inlet and outlet of AC Unit, air handler, and heating/evaporative cooler unit. Provide galvanized weather hood over

HEATING, VENTILATING AND AIR CONDITIONING 23 05 10 - 4 flexible connections exposed to the weather.

- I. Provide lateral bracing per Section 230500.
- J. Ducts shall clear combustible construction by 1" minimum.
- K. Seal airtight transverse seams of all supply and return ducts. Refer to Mechanical General Requirements specifications. Duct leakage shall not exceed 1%.
- L. Provide Ventlok #699 test hole fittings where indicated or specified.
- M. All materials except sheet metal including duct liner shall be approved before installation.

### 3.5 DAMPERS:

- A. Provide opposed blade manual air dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide Ventlok regulators. Provide an opposed blade balancing damper in each zone supply duct. Damper blades shall be 16 gauge minimum galvanized steel with 3/8" minimum shaft, and 10" maximum blade width. Provide an access panel or Ventlok flush-type damper regulator on ceiling or wall for each concealed damper.
- B. Provide 18" x 12" minimum access doors in ductwork and furring for easy access to each fire damper; insulated access doors in insulated ducts. Label access doors with 1/2" high red letters.
  - 1. Provide Ventlok access doors with Series 100 hardware for convenient access to all automatic dampers and other components of the system, insulated type in insulated ducts. Provide Ventlok #202 for light duty up to 2" thick doors, #260 heavy duty up to 2"k thick doors and #310 heavy duty for greater than 2" thick doors. Provide #260 hinges on all hinged and personnel access doors, include gasketing.

# 3.6 FANS:

- A. Provide access doors for fans or motors mounted in ductwork.
- B. Mount all fans so that they are completely isolated from building.
- C. Fan motors mounted in air-stream to be totally enclosed.
- D. Completely line supply, return or exhaust fan cabinets with 1" thick, 3/4 lbs. density acoustic insulation securely cemented in place.
- E. Roof fans shall be mounted level.
- 3.7 EQUIPMENT CHECK, TEST AND START:
  - A. The check, test and start of each air conditioning unit, make-up air unit, air handler unit and gas unit heater shall be performed by a specialized company, Aircon Service, Commercial Air, or equal, acting as a subcontractor to the air conditioning contractor. The company selected shall have had experience on

similar projects and shall have demonstrated by past performance that the personnel are qualified to do such work. The firm selected shall have approval of the Architect prior to start of work.

- B. The company shall provide all personnel, test instruments, and equipment to properly perform the check, test and start.
- C. The check, test and start of each item of equipment shall be in accordance with manufacturer's printed instructions. Three (3) copies of the completed check, test and start report of each item of equipment shall be bound with the operating and maintenance instructions.
- D. Upon completion of the work, provide a schedule of planned maintenance indicating frequency of service for all equipment components. Post schedule where directed under plastic.
- 3.8 TESTING AND BALANCING (SMALL AND MEDIUM SIZE; INDEPENDENT TEST):
  - A. Obtain the service of an independent test and balance agency that specialized in, and whose business is limited to, testing and balancing of air conditioning systems.
  - B. Coordinate work done by testing and balancing agency with work of other trades.
  - C. Testing and balancing agency, as a part of its contract, shall act as authorized inspection agency and shall report any discrepancies or items not installed in accordance with Contract Drawings and/or Specifications pertaining to air and water distribution, and exhaust systems.
  - D. Contractor shall provide for adjustments and/or additions or modifications to fan and motor sheaves, belts, damper linkages and the like to achieve proper air balance at no additional cost.
  - E. Testing and balancing shall be performed in complete accordance with AABC National Standards for Field Measurement and Instrumentation, Volume Four. Testing and balancing shall be performed on air distribution system, chilled water system, condenser water system, heating water system, and domestic water system.
  - F. Balance air quantities of supply and exhaust to achieve those given on Drawings. Measure the total air quantity at each fan. Measure the total air quantity at each supply fan with maximum outside air and with minimum outside air. Measure the ampere reading of each motor input after final adjustments have been made. Provide static pressure profile for each air moving equipment. Upon satisfactory completion of balance and operational test, submit three (3) sets of reports to the Architect on balance final readings, summary of fan CFM delivery rates, static pressure ratings, motor ampere input, and general summary of test results. Specified ratings and motor nameplate ratings shall be listed with measured readings.
  - G. Instruments used for testing and balancing of systems shall have been calibrated within a period of six (6) months and shall be checked for accuracy prior to start of work.

- H. Three (3) copies of complete test report shall be submitted prior to final acceptance of project.
- I. Tabulate magnetic starters size, type, and manufacturer with heater strip size, type and rating along with motor nameplate data.
- J. Air balance shall be achieved using variable fan speeds.
- K. Adjust single or double deflection registers and variable pattern diffusers to evenly distribute air within the conditioned space. The terminal air velocity at 5' above the floor shall not exceed 50 FPM in normal air conditioned spaces.
- L. Measure the ampere reading of each motor input after final adjustments have been made.
- M. Hydronic System Balancing
  - 1. Calibration and testing of hydronic system in conformance with AABC recommendations.
  - 2. Complete air balance prior to hydronic system balancing.
  - 3. Water Balance Procedures: Set combination chilled/hot water, and condenser water and hot water pumps to design GPM quantities.
  - 4. Check and adjust water temperature and GPM flow characteristics at all cooling and heating coils.
  - 5. Upon completion of flow ratings and coil adjustments, mark all settings and record all data.
  - 6. Recorded data shall include:
    - a. Inlet and leaving temperatures at all coils and heating and cooling equipment.
    - b. Pressure drop at each coil including coil bypass.
    - c. Pump operating suction and discharge pressure and final total dynamic pump head.
    - d. Rated and actual running amperage of pump motors.
  - 7. Venturies and calibrated orifices with portable or permanent flow meters shall be used to balance the waterflows. When above equipment is not installed, obtain waterflow balance by measurement of temperature differential across the various coils or elements.

#### 3.9 EQUIPMENT MOUNTING:

A. Mounting and anchorage of equipment shall be in strict compliance with drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.
# SECTION 23 11 13

### FACILITY FUEL-OIL 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. Fuel-oil pipes, tubes, and fittings.
  - 2. Double-containment piping and fittings.
  - 3. Piping specialties.
  - 4. Joining materials.
  - 5. Specialty valves.
  - 6. Mechanical leak-detection valves.
  - 7. Leak detection and monitoring system.
  - 8. Labels and identification.

### 1.3 DEFINITIONS

- A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
  - 2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. For valves, include pressure rating, capacity, settings, and electrical connection data of selected models.
- B. Shop Drawings: For fuel-oil piping.
  - 1. Include plans, elevations sections, hangers, and supports for multiple pipes.
  - 2. Include details of location of anchors, alignment guides, and expansion joints and loops.
  - 3. Scale: 1/4 inch per foot.
- C. Delegated-Design Submittal: For fuel-oil piping indicated to comply with performance requirements and design criteria.
  - 1. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 2. Detail fabrication and assembly of anchors and seismic restraints.
  - 3. Design Calculations: Calculate requirements for selecting seismic restraints.

4. Detail fabrication and assembly of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
  - 1. Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.
  - 2. Site Survey: Plans, drawn to scale, on which fuel-oil piping and tanks are shown and coordinated with other services and utilities.
- B. Brazing certificates.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

# 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

# 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.

### 1.8 QUALITY ASSURANCE

- A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- C. Pipe Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code.
- 1.9 DELIVERY, STORAGE, AND HANDLING
  - A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
  - B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
  - C. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.
  - D. Store PE pipes and valves protected from direct sunlight.
- 1.10 WARRANTY
  - A. Special Warranty: Manufacturer agrees to repair or replace components of flexible, doublecontainment piping and related equipment that fail in materials or workmanship within specified warranty period.
    - 1. Failures due to defective materials or workmanship for materials including piping, dispenser sumps, water-tight sump entry boots, terminations, and other end fittings.
    - 2. Warranty Period: 10 years from date of Substantial Completion.

### PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
- C. Fuel-Oil Valves: Comply with UL 842 and have service mark initials "WOG" permanently marked on valve body.
- D. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil piping.

# 2.2 PERFORMANCE REQUIREMENTS

- A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraints and anchors and multiple pipe supports and hangers for fuel-oil piping.
- 2.3 FUEL-OIL PIPES, TUBES, AND FITTINGS
  - A. See "Outdoor Piping Installation" and "Indoor Piping Installation" articles for where pipes, tubes, fittings, and joining materials are applied in various services.
  - B. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
    - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
    - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
    - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
    - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      - a. Material Group: 1.1.
      - b. End Connections: Threaded or butt welding to match pipe.
      - c. Lapped Face: Not permitted underground.
      - d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
      - e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
    - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

### 2.4 DOUBLE-CONTAINMENT PIPE AND FITTINGS

- A. Flexible, Nonmetallic, Double-Containment Piping: Comply with UL 971.
  - 1. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment piping.
  - 2. Fiberglass sumps.
  - 3. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
  - 4. Minimum Operating Pressure Rating: 10 psig.
  - 5. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 6. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
- B. Flexible, Metallic, Double-Containment Piping: Comply with UL 971A.

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- 1. Pipe Materials:
  - a. Metallic Lining: ASTM A 240/ASTM A 240M Type 304 corrugated stainless steel tubing.
  - b. Carrier Pipe: Fluoropolymer tube.
  - c. Jacket: UV stabilized.
- 2. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
- 3. Minimum Operating Pressure Rating: 10 psig.
- 4. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
- 5. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
- C. Rigid, Double-Containment Piping: Comply with UL 971.
  - 1. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
    - a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3: 150 psig.
  - 2. Leak-Detection System: Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

### 2.5 PIPING SPECIALTIES

- A. Metallic Flexible Connectors:
  - 1. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
  - 2. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
  - 3. Minimum Operating Pressure: 150 psig.
  - 4. End Connections: Socket, flanged, or threaded end to match connected piping.
  - 5. Maximum Length: 30 inches.
  - 6. Swivel end, 50-psig maximum operating pressure.
  - 7. Factory-furnished anode for connection to cathodic protection.
- B. Nonmetallic Flexible Connectors:
  - 1. Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.
  - 2. PFTE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
  - 3. Minimum Operating Pressure: 150 psig.
  - 4. End Connections: Socket, flanged, or threaded end to match connected piping.
  - 5. Maximum Length: 30 inches.
  - 6. Swivel end, 50-psig maximum operating pressure.
  - 7. Factory-furnished anode.
- C. Y-Pattern Strainers:
  - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 80-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.
- D. Basket Strainers:
  - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 80-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- E. T-Pattern Strainers:
  - 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
  - 2. End Connections: Grooved ends.
  - 3. Strainer Screen: 80-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
  - 4. CWP Rating: 750 psig.
- F. Manual Air Vents:
  - 1. Body: Bronze.
  - 2. Internal Parts: Nonferrous.
  - 3. Operator: Screwdriver or thumbscrew.
  - 4. Inlet Connection: NPS 1/2.
  - 5. Discharge Connection: NPS 1/8.
  - 6. CWP Rating: 150 psig.
  - 7. Maximum Operating Temperature: 225 deg F.
- 2.6 JOINING MATERIALS
  - A. Joint Compound and Tape for Threaded Joints: Suitable for fuel oil.
  - B. 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.
  - C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
  - D. Bonding Adhesive for RTRP and RTRF: As recommended by piping and fitting manufacturer.

# 2.7 SPECIALTY VALVES

- A. Pressure Relief Valves:
  - 1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  - 2. Body: Brass, bronze, or cast steel.
  - 3. Springs: Stainless steel, interchangeable.
  - 4. Seat and Seal: Nitrile rubber.
  - 5. Orifice: Stainless steel, interchangeable.

- 6. Factory-Applied Finish: Baked enamel.
- 7. Maximum Inlet Pressure: 150 psig.
- 8. Relief Pressure Setting: 60 psig.
- B. Oil Safety Valves:
  - 1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  - 2. Body: Brass, bronze, or cast steel.
  - 3. Springs: Stainless steel.
  - 4. Seat and Diaphragm: Nitrile rubber.
  - 5. Orifice: Stainless steel, interchangeable.
  - 6. Factory-Applied Finish: Baked enamel.
  - 7. Manual override port.
  - 8. Maximum Inlet Pressure: 60 psig.
  - 9. Maximum Outlet Pressure: 3 psig.
- C. Emergency Shutoff Valves:
  - 1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  - 2. Double poppet valve.
  - 3. Body: ASTM A 126, cast iron.
  - 4. Disk: FPM.
  - 5. Poppet Spring: Stainless steel.
  - 6. Stem: Plated brass.
  - 7. O-Ring: FPM.
  - 8. Packing Nut: PTFE-coated brass.
  - 9. Fusible link to close valve at 165 deg F.
  - 10. Thermal relief to vent line pressure buildup due to fire.
  - 11. Air test port.
  - 12. Maximum Operating Pressure: 0.5 psig.
- 2.8 MECHANICAL LEAK-DETECTION VALVES
  - A. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  - B. Body: ASTM A 126, cast iron.
  - C. O-Rings: Elastomeric compatible with fuel oil.
  - D. Piston and Stem Seals: PTFE.
  - E. Stem and Spring: Stainless steel.
  - F. Piston Cylinder: Burnished brass.
  - G. Indicated Leak Rate: Maximum 3 gph at 10 psig.
  - H. Leak Indication: Reduced flow.
- 2.9 LEAK-DETECTION AND MONITORING SYSTEM
  - A. Cable and Sensor System: Comply with UL 1238.

- 1. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil piping.
- 2. Include fittings and devices required for testing.
- 2.10 LABELS AND IDENTIFICATION
  - A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inche wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.
- PART 3 EXECUTION
- 3.1 EXAMINATION
  - A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel-oil piping.
  - B. Examine installation of fuel-burning equipment and fuel-handling and storage equipment to verify actual locations of piping connections before installing fuel-oil piping.
  - C. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 EARTHWORK
  - A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
- 3.3 PREPARATION
  - A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
  - B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

# 3.4 OUTDOOR PIPING INSTALLATION

- A. Install Underground Fuel-Oil Piping Buried:
  - 1. Under Compacted Backfill: 18 inches below finished grade.
  - 2. Under Asphalt 2 Inches Thick: 8 inches below bottom of asphalt.
  - 3. Under 4 Inches of Reinforced Concrete in Areas Subject to Vehicle Traffic: 4 inches below bottom of concrete.
  - 4. If fuel-oil piping is installed with less than 12 inches of cover to finished grade, install in containment piping.
  - 5. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
- B. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage with Architect prior to repair.
  - 3. Replace pipe having damaged PE coating with new pipe.
- C. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fueloil storage tank sump.
- D. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
- E. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.
- F. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.

- G. Install fittings for changes in direction in rigid pipe.
- H. Install system components with pressure rating equal to or greater than system operating pressure.
- 3.5 INDOOR PIPING INSTALLATION
  - A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.
  - C. Install piping in concealed locations 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 at a height that allows sufficient space for ceiling panel removal.
  - F. Install piping free of sags and bends.
  - G. Install fittings for changes in direction and branch connections.
  - H. Comply with requirements for equipment specifications for roughing-in requirements.
  - I. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
  - J. Prohibited Locations:
    - 1. Do not install fuel-oil piping in or through HVAC ducts and plenums, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    - 2. Do not install fuel-oil piping in solid walls or partitions.
  - K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
  - L. Connect branch piping from top or side of horizontal piping.
  - M. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
  - N. Do not use fuel-oil piping as grounding electrode.
  - O. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
  - P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

# 3.6 VALVE INSTALLATION

- A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- B. Install valves in accessible locations.
- C. Install oil safety valves at inlet of each oil-fired appliance.
- D. Install pressure relief valves in distribution piping between the supply and return lines.
- E. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping. Comply with requirements in Section 230523.12 "Ball Valves for HVAC Piping."
- F. Install manual air vents at high points in fuel-oil piping.
- G. Install emergency shutoff valves at dispensers.

# 3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. 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 unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Bevel plain ends of steel pipe.
  - 2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tubing" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
- G. Flared Joints: Comply with SAE J513. Tighten finger tight then use wrench according to fitting manufacturer's written instructions. Do not overtighten.
- H. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.8 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements for hangers, supports, and anchor devices specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for steel piping, 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.
- D. Support horizontal piping within 12 inches of each fitting and coupling.
- E. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

## 3.9 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

- A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.
- B. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor probes at low points in piping.
- 3.10 CONNECTIONS
  - A. Where installing piping adjacent to equipment, allow space for service and maintenance.
  - B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
  - C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
  - D. Connect piping to equipment with shutoff valve and union. Install union between valve and equipment.

- E. Install flexible piping connectors at final connection to burners or oil-fired appliances.
- 3.11 LABELING AND IDENTIFYING
  - A. Nameplates, pipe identification, valve tags, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."
  - B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.
    - 1. Text: In addition to identifying unit, distinguish between multiple units; inform operator of operational requirements; indicate safety and emergency precautions; and warn of hazards and improper operations.
  - C. Install detectable warning tape directly above fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.
    - 1. Piping: Over underground fuel-oil distribution piping.

# 3.12 FIELD QUALITY CONTROL

- A. Pressure Test Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
  - 1. Fuel-Oil Distribution Piping: Minimum 5 psig for minimum 30 minutes.
  - 2. Fuel-Oil, Double-Containment Piping:
    - a. Carrier Pipe: Minimum 5 psig for minimum 30 minutes.
    - b. Containment Conduit: Minimum 5 psig for minimum 60 minutes.
  - 3. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.
  - 4. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.
- B. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
- C. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Bleed air from fuel-oil piping using manual air vents.
- F. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- 3.13 OUTDOOR PIPING SCHEDULE
  - A. Underground Fuel-Oil Piping: Rigid, double-containment piping. Size indicated is carrier-pipe size.
  - B. Aboveground fuel-oil piping shall be one of the following:
    - 1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
    - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
- 3.14 SHUTOFF VALVE SCHEDULE
  - A. Valves for aboveground distribution piping NPS 2 and smaller shall be one of the following:
    - 1. One-piece, bronze ball valve with bronze trim.
    - 2. Two-piece, full-port, bronze ball valves with bronze trim.

- B. Valves in branch piping for single appliance shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

# SECTION 23 12 13

### FACILITY FUEL-OIL PUMPS

## 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. Submersible fuel-oil storage tank pumps.
  - 2. Simplex fuel-oil pumps.
  - 3. Duplex fuel-oil pumps.
  - 4. Triplex fuel-oil pumps.
  - 5. Fuel-oil maintenance systems.

### 1.3 DEFINITIONS

- A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
  - 2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fuel-oil pumps.
  - 1. Include construction details and dimensions of individual components for fuel-oil pumps.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Scale: 1/4 inch per foot.
- C. Delegated-Design Submittal: For fuel-oil pumps.
  - 1. Detail fabrication and assembly of anchors and seismic restraints.
  - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
  - 3. Detail fabrication and assembly of hangers, supports, and attachments of the same to building structure.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Seismic Qualification Certificates: For fuel-oil pumps from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.
- 1.6 CLOSEOUT SUBMITTALS
  - A. Operation and Maintenance Data: For fuel-oil pumps and fuel-oil maintenance systems to include in emergency, operation, and maintenance manuals.
- 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. Drive Belt: One for each belt-driven pump.

# PART 2 - PRODUCTS

- 2.1 PERFORMANCE REQUIREMENTS
  - A. Maximum Operating-Pressure Ratings: 50 psi fuel-oil supply pressure at oil-fired appliances.
  - B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for fuel-oil pumps, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - C. Seismic Performance: Factory-installed support attachments for pumps shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
    - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[ and the unit will be fully operational after the seismic event]."
  - D. 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.
  - E. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
- 2.2 DUPLEX FUEL-OIL TRANSFER PUMP SETS
  - A. Description: Comply with HI 3.1-3.5.
    - 1. Type: Positive-displacement, rotary type.
    - 2. Impeller: Steel gear with crescent.
    - 3. Housing: Cast-iron foot mounted.
    - 4. Bearings: Bronze, self-lubricating.
    - 5. Shaft: Polished steel.
    - 6. Seals: Mechanical.
    - 7. Base: Steel.
    - 8. Pressure Relief: Built in.
    - 9. Discharge Check Valve: Built in.
  - B. Controls:
    - 1. Maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.
    - 2. Seven-day schedule.
    - 3. Stage multiple pumps to maintain pressure at a common supply manifold.

- 4. Alternate pumps to equalize run time.
- 5. Alarm motor failure.
- 6. Manual reset dry-run protection.
- 7. Stop pumps if fuel level falls below pump suction.
- 8. De-energize and sound alarm for pump, locked-rotor condition.
- 9. Sound alarm for open circuit and for high and low voltage.
- 10. Lights shall indicate normal power on, run, and off conditions.
- 11. Interface with automatic control system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" to control and indicate the following:
  - a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
  - b. Operating status.
  - c. Alarm off-normal status.
- C. Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.
- D. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.
- E. Capacities and Characteristics:
  - 1. See plans for schedule.
- 2.3 FUEL MAINTENANCE SYSTEM
  - A. Description: Factory-fabricated and wired fuel maintenance system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls.
    - 1. System shall be FMG approved and listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - 2. Enclosure: NEMA 250, Type 3R, painted steel containing pumps, filters, accessories, and controls. Hinged door on the front of enclosure.
    - 3. Pump: Comply with HI 3.1-3.5, steel gear with crescent, positive displacement, direct coupled, rotary type.
    - 4. Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-in, pressure relief bypass valve.
    - 5. Piping: Steel with malleable-iron fittings and threaded joints or wrought-steel fittings and welded joints.
    - 6. Spin-On, Replaceable, Multistage Filters:
      - a. Stage 1: 100-mesh strainer.
      - b. Stage 2: Centrifuge to separate particulates and water from oil.
      - c. Stage 3: Coalescing water and particulate filter.
      - d. Stage 4: 30-micron particulate removal.
      - e. Stage 5: 10-micron particulate removal.
      - f. Stage 6: Minimum 99.5 percent water removal with see-through bowl and watersensor probe.
      - g. Stage 7: [1.5] [3]-micron particulate removal.
    - 7. Multiple-Tank Manifolds:
      - a. Manifold fabricated of Schedule 80, black steel pipe and threaded nipples for two tanks.

- b. Solenoid valves for supply and return piping to each tank.
- c. Strainers for each tank supply connection.
- 8. Programmable Logic Controller:
  - a. Alarm on maximum 15-in. Hg vacuum at pump suction indicating plugged filter.
  - b. Alarm on high water level in filter.
  - c. Alarm leak in enclosure.
  - d. Touch screen; with minimum 2-line, 20-character, backlit, LCD display.
  - e. Controller strip heater with thermostat.
- 9. Interface with automatic control system is specified in Section 230900 "Instrumentation and Control for HVAC" to control and indicate the following:
  - a. Start/stop system when required by schedule.
  - b. Operating status.
  - c. Alarm off-normal status.
- B. Capacities and Characteristics:
  - 1. See plans.
- 2.4 MOTORS
  - A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- PART 3 EXECUTION
- 3.1 EXAMINATION
  - A. Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.
  - B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 EARTHWORK
  - A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
- 3.3 PREPARATION
  - A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
  - B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.
- 3.4 FUEL-OIL PUMP INSTALLATION
  - A. Submersible Pumps:
    - 1. Suspend pumps from supply piping and anchored to bottom of tank.
  - B. Transfer Pumps:
    - 1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
    - 2. Set pumps on and anchor to concrete base.
    - 3. Pump Mounting:
      - a. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
      - b. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

- c. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Install two-piece, full-port ball valves at suction and discharge of pumps. Comply with requirements in Section 230523.12 "Ball Valves for HVAC Piping."
- D. Install mechanical leak-detector valves at pump discharge.
- E. Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.
- F. Install check valve on discharge of simplex fuel-oil pumps.
- G. Install suction piping with minimum fittings and change of direction.
- H. Install vacuum and pressure gage, upstream and downstream, respectively, at each pump to measure the differential pressure across the pump. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- 3.5 FUEL MAINTENANCE SYSTEM INSTALLATION
  - A. Install suction line, with foot valve, at one end of storage tank, 1 inch from the bottom of tank.
  - B. Install return line at the opposite end of storage tank from suction line.
- 3.6 LABELING AND IDENTIFYING
  - A. Install nameplates and signs on each fuel-oil pump. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment."
- 3.7 FIELD QUALITY CONTROL
  - A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - B. Perform the following tests and inspections:
    - 1. Start fuel-oil transfer pumps to verify for proper operation of pump, and check for leaks.
    - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - C. Fuel-oil pumps will be considered defective if they do not pass tests and inspections.
  - D. Prepare test and inspection reports.
- 3.8 DEMONSTRATION
  - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-oil pumps.

# END OF SECTION

# SECTION 23 13 23

## FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS

- 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. Vertical, steel, fuel-oil ASTs.
    - 2. Concrete-vaulted, steel, fuel-oil ASTs.
- 1.3 DEFINITIONS
  - A. AST: Aboveground storage tank.
- 1.4 ACTION SUBMITTALS
  - A. Product Data: For each type of product.
    - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
    - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
    - 3. Fuel-oil storage tank accessories.
  - B. Shop Drawings:
    - 1. Include plans, elevations, sections, and ballast pads and anchors, and lifting or supporting points.
    - 2. Indicate dimensions, components, and location and size of each field connection.
    - 3. Shop Drawing Scale: 1/4 inch per foot.
- 1.5 INFORMATIONAL SUBMITTALS
  - A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are shown and coordinated with other services and utilities.
  - B. Qualification Data: For qualified professional engineer.
  - C. Seismic Qualification Data: For ASTs, accessories, and components, from manufacturer.
    - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - D. Brazing certificates.
  - E. Welding certificates.
  - F. Field quality-control reports.
  - G. Sample Warranty: For special warranty.
- 1.6 CLOSEOUT SUBMITTALS
  - A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

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## 1.7 QUALITY ASSURANCE

- A. EPA Compliance: Comply with EPA and state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks.
- B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."

# 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.
  - 1. Storage Tanks:
    - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
      - 1) Structural failures including cracking, breakup, and collapse.
      - 2) Corrosion failure including external and internal corrosion of steel tanks.
    - b. Warranty Period: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for fuel-oil ASTs, and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.
- B. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- 2.2 VERTICAL, STEEL, FUEL-OIL AST
  - A. Description: UL 142, single-wall, vertical, steel tank.
  - B. Description: UL 142, double-wall, vertical, steel tank; with primary- and secondary-containment walls and interstitial space.
  - C. Construction: Fabricated with welded, carbon steel suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and maintained temperature up to 150 deg F.
  - D. Capacities and Characteristics:
    - 1. See plans.
- 2.3 CONCRETE-VAULTED, STEEL, FUEL-OIL AST
  - A. Description: UL 142, UL 2085, and STI F941; thermally insulated, fire-resistant and protected, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.
  - B. Construction: Fabricated with welded, carbon steel and insulation and encased in concrete that will protect from bullets; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.
  - C. Capacities and Characteristics:
    - 1. See plans.
- 2.4 SHOP PAINTING OF AST
  - A. Apply manufacturer's standard prime coat to exterior steel surface of AST and supports.
  - B. Prepare exterior steel surface of AST and tank supports.

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- C. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3.
- D. After cleaning, remove dust or residue from cleaned surfaces.
- E. If surface develops rust before prime coat is applied, repeat surface preparation.
- F. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.
- G. Apply manufacturer's standard two-component, epoxy finish coats.

# 2.5 FUEL-OIL AST ACCESSORIES

- A. Tank Manholes: 22-inch-minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
- B. Tank Manholes: 22-inch-minimum diameter; bolted, flanged, and gasketed; on top and at side of tank.
- C. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
- D. Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
- E. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
- F. Lifting Lugs: For handling and installation.
- G. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
- H. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Section 055000 "Metal Fabrications" for exterior steel ladder.
  - 1. Cage: Include welded steel cage around ladders for tanks 20 feet high or higher.
- I. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- J. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

# 2.6 LIQUID-LEVEL GAGE SYSTEM

- A. Description: Calibrated liquid-level gage system complying with UL 1238 with probes or other sensors and remote annunciator panel.
- B. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
- C. Controls: Electrical, operating on 120-V ac.

# 2.7 LEAK-DETECTION AND MONITORING SYSTEM

- A. Cable and Sensor System: Comply with UL 1238.
  - 1. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
  - 2. Include fittings and devices required for testing.
  - 3. Controls: Electrical, operating on120-V ac.
  - 4. Calibrated liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.
  - 5. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
  - 6. Controls: Electrical, operating on 120-V ac.

- B. Hydrostatic System: Comply with UL 1238.
  - 1. Calibrated leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
  - 2. Include fittings and devices required for testing.
  - 3. Controls: Electrical, operating on 120-V ac.
  - 4. Calibrated liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.
  - 5. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
  - 6. Controls: Electrical, operating on 120-V ac.
- 2.8 FUEL OIL
  - A. Fuel Oil: ASTM D396, Grade No. 2.
  - B. Diesel Fuel Oil: ASTM D975, Grade Low Sulfur, high volatility.
- 2.9 SOURCE QUALITY CONTROL
  - A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
    - 1. Vertical, Single-Wall Steel ASTs: UL 142.
    - 2. Concrete-Vaulted, Steel ASTs: UL 142 and UL 2085.
  - B. Affix standards organization's code stamp.

# PART 3 - EXECUTION

- 3.1 EXAMINATION
  - A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.
  - B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 EARTHWORK
  - A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
  - B. Allow for cast-in-place, concrete base.

### 3.3 FUEL-OIL AST INSTALLATION

- A. Install tank bases and supports.
- B. Concrete Bases: Anchor AST to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

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- C. Connect piping and vent fittings.
- D. Install ground connections.
- E. Install tank leak-detection and monitoring devices.
- F. Install steel ASTs according to STI R912.
- G. Install insulated and concrete-vaulted, steel ASTs according to STI R942.
- H. Fill storage tanks with fuel oil.
- 3.4 LIQUID-LEVEL GAGE SYSTEM INSTALLATION
  - A. Install liquid-level gage system. Install panel inside building where indicated.

# 3.5 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

- A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.
  - 1. Double-Wall, Fuel-Oil Storage Tanks: Use factory-installed integral probes in interstitial space.
  - 2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated.
  - 3. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping cable probes in interstitial space of double-containment piping.
  - 4. Install liquid-level gage.
- 3.6 LABELING AND IDENTIFYING
  - A. Nameplates, pipe identification, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."

# 3.7 FIELD PAINTING OF AST

- A. Prepare and touch up damaged exterior surface of AST and supports as specified in "Shop Painting of AST" Article.
- B. Prepare exterior steel surface of AST and tank supports.
- C. Field Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3.
- D. After cleaning, remove dust or residue from cleaned surfaces.
- E. If surfaces develop rust before prime coat is applied, repeat surface preparation.
- F. Prepare surface of AST and supports and apply painting systems according to specifications in Section 099600 "High-Performance Coatings" for severe environment high-gloss finish for ferrous metal.

# 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
    - a. Single-Wall Tanks: Minimum 3 psig and maximum 5 psig.
    - b. Double-Wall Tanks:
      - 1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
      - 2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.

- c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
- d. Maintain the test pressure for one hour.
- C. ASTs will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

# END OF SECTION

# SECTION 23 21 13

### HYDRONIC SYSTEMS AND EQUIPMENT

#### PART 1 – GENERAL

#### 1.1 WORK INCLUDED:

A. Types of hydronic specialties specified in this section include the following:

Vent Valves Flow Control Valves Air Separators Expansion Tanks Chemical Feeders Hydronic Piping Water Relief Valves

#### 1.2 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
  - 1. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping."
  - 2. UMC Compliance: Fabricate and install hydronic piping in accordance with IAPMO "Uniform Mechanical Code."
  - 3. Welding materials and labor shall conform to ASME Code and applicable state labor regulations.
  - 4. Welders shall be fully qualified and certified by a state approved welding bureau. Each welder shall identify his work with a marking stamped on each weld joint of pipe.
  - 5. Copper brazing (including Medical Gas -Medical vacuum pipe and fittings:
    - 1. Certified yearly by P.I.P.E. or agency that meets AMS B2.2-85 brazing procedures, American Welding Society Standards.
    - 2. Show current brazing certificates upon request. Certification shall be copied and kept on file by Contractor for duration of the job and provided to Owner's Representative to be kept on file by Owner's Plant Operations and Maintenance Plumbing Supervisor.

### 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of hydronic specialty.
- B. Record Drawings: At project closeout, submit Record Drawings of installed hydronic piping and piping products in accordance with requirements of Division 1.

C. Maintenance Data: Submit maintenance data and parts lists for hydronic piping materials and products. Include this data, product data, Shop Drawings, and Record Drawings in maintenance manual in accordance with requirements of Division 1.

# PART 2 - PRODUCTS

### 2.1 MATERIALS:

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on hydronic piping systems maximum design pressures or as specified. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems.

#### 2.2 BASIC PIPES AND PIPE FITTINGS:

- A. Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings," in accordance with the following listing:
  - Chilled Water Piping: ASTM A53 or ASTM A120 black steel, Schedule 40, with standard-weight, full-radius, butt-welding fittings and 150-lb., forged-steel, weld-neck type flanges. Connections to threaded equipment, valves, etc. shall be made with 150-lb., cast-iron, threaded fittings. Piping 2 inches and smaller shall have 150-lb., screwed, cast-iron fittings. Slip-on flanges will be permitted where space is limited with prior approval of the Owner's Representative. All slip-on flanges shall be back-welded.
  - 2. Heating Water Piping:
    - a. ASTM A53 or ASTM A120 black steel Schedule 40. On pipe sizes 2 inches and smaller, 125-lib., cast-iron, threaded steam pattern fittings. On pipe sizes 2-1/2 inches and larger, standard-weight, full-radius, butt-welding fittings and weld neck flanges, except slip-on flanges as specified for chilled water piping. Connections to threaded equipment, valves, etc. shall be made with cast-iron, threaded fittings.
    - b.
    - c. Copper type "L" ASTM B 88 with wrought Copper fittings. Piping 2 ½" and larger shall be brazed piping 2" and smaller may be soldered with Canfield 100% water safe.
  - 3. Condenser Water Piping: ASTM A53 or ASTM A120 black steel, Schedule 40, with standard-weight, full-radius, butt-welding fittings and weld neck flanges.
  - 4. Water and Drain Connections to Equipment or to Stubs by Plumbing Contractor: Schedule 40 steel pipe with 150-lb., malleable-iron fittings. Provide dielectric unions if connections are to copper lines. Pipe and fittings shall be black or galvanized as required to match piping to which connected.
  - 5. Air Vent Discharge Piping: Type-L, hard copper tubing with wrought copper solder joint fittings and 95 percent tin, 5 percent antimony solder.
  - 6. Cooling Coil Condensate Drain Piping: ASTM A120 or ASTM A53 galvanized steel, Schedule 40 with 125-lb., galvanized, cast-iron fittings or 150-lb., galvanized, malleable-iron fittings. At Contractor's option, piping same as for air vent discharge piping may be used. Provide plugged tees or crosses at all changes in direction. Plugs shall utilize the same material as the primary piping or shall be equipped with dielectric couplings.

7. Relief Valve Discharge and Vapor Vent Piping: Same as specified for cooling coil condensate drain piping, except that plugged fittings will not be required.

# 2.3 AIR SEPARATORS:

- A. Provide air separators pressure rated for 125 psi. Select capacity based on total system gpm.
- B. In-Line Air Separators: Provide in-line air separators as indicated. Construct sizes 1-1/2 inches and smaller of cast iron and sizes 2 inches and larger of steel complying with ASME Boiler and Pressure Vessel Code for 125 psig and stamped with "U" symbol.
- C. Manufacturers: Amtrol, Inc., Armstrong Pumps, Inc., Bell and Gossett ITT; Fluid Handling Division, or equal.

# 2.4 EXPANSION TANKS:

- A. General: Provide expansion tanks of size and number as indicated. Construct of steel for 125 psi pressure rating complying with ASME Boiler and Pressure Vessel Code and stamped with "U" symbol. Furnish National Board Form U-1 denoting compliance. Provide tappings in bottom of tank for tank fitting; tappings in top and bottom of tank for gauge glass connections. Provide <sup>3</sup>/<sub>4</sub>-inch, full-length gauge glass, with gauge cocks and cleanouts.
- B. Tank Fittings: Provide tank fittings for expansion tanks as indicated, sized for tank diameter. Design tank fittings for 125 psi pressure rating and include manual vent to establish proper air volume in tank on initial fill.
- C. Manufacturers: Amtrol, Inc., Armstrong Pumps, Inc., Bell and Gossett ITT; Fluid Handling Division, or equal.

# 2.5 DIAPHRAGM-TYPE EXPANSION TANKS:

- A. Provide diaphragm expansion tanks of size and number as indicated. Construct tank of welded steel, constructed, tested, and stamped in accordance with Section VIII of ASME Boiler and Pressure Vessel Code for working pressure of 125 psi. Furnish National Board Form U-1 denoting compliance. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air-charging fitting and drain fitting.
- B. Manufacturers: Amtrol, Inc., Armstrong Pumps, Inc., Taco, or equal.
- 2.6 CHILLED WATER AND HEATING WATER CHEMICAL FEEDERS:
  - A. Provide chemical feeders of 5-gal. Capacity or otherwise as indicated, constructed of cast iron or steel, for introducing chemicals in closed hydronic system. Provide funnel and valve on top for loading, drain valve in bottom, and recirculating valves on side. Construct for pressure rating of 125 psi.
  - B. Manufacturers:

Dearborn Neptune Chemical Pump Company J.L. Wingert Company Vulcan Laboratories, Subsidiary of Clow Corporation Or Equal

Model DBF-5 Model 5HD

09/29/2023

# 2.7 COOLING TOWER SYSTEM CHEMICAL TREATMENT:

- A. Furnish and install an automatic feed and bleed system as diagramed on the Drawings and as specified herein. Equipment shall be as follows:
- B. Electronic feed and bleed controller shall be Lakewood, or equal, equipped with power relay with a conductance range of 0 to 9,000 micro ohms. Controller shall be able to control 2 biocides and control an inhibitor. Provide with conductivity alarm point and connect to DDC system for out of range alarm.
- C. Chemical pump shall be Precision chemical feed pumps, or equal, with minimum capacity of 0.10 to 3.4 GPD at 75 psi. Provide with acrylic head and fittings and Hypalon diaphragm and valves.
- D. The no corrosive chemical tanks shall be the chemical shipping container. Provide stainless steel secondary containment for tanks. Minimum size shall be large enough in volume to hold contents of largest container. Minimum height of secondary containment shall be 10".
- E. The solenoid valve shall be normally closed, Griswold Model 4160, or equal, with General Purpose (NEMA 1) enclosure. Steam blowdown valves shall be slow opening and closing.
- F. Provide corrosion coupon rack for corrosion monitoring capability.
- G. Provide all piping and tubing for chemical treatment system. Piping shall be schedule 80 PVC and shall be run in rigid conduit to provide continuous support.
- H. Manufacturers: Nalco, Ecolab, GE Betz, or approved equal.
- 2.8 BASIC VALVES:
  - A. Provide valves complying with Division 23 Basic Mechanical Materials and Methods Sections, in accordance with the following listing.
  - B. Balance Valves:
    - Shall be Armstrong, Victaulic TA, B & G Circuit Setter, or equal in design. Valve shall provide multi-turn, 360 degrees adjustment with a micrometer type indicator located on valve hand wheel. Valve handwheel shall have hidden memory feature which will provide a means for locking the valve in position after the system is balanced. Plug design valves are not acceptable. 90 degree turn adjustable valves are not acceptable.
    - 2. 2 Inches and Smaller: Ball Valves
    - 3. 2-1/2 Inches and Larger: Butterfly Valves
  - C. Air Vent Valves:
    - 1. Manual air vents: At all high points, reheat coils, the air vent assemblies shall consist of a 1/4" sov and a 2" x 12" nipple air chamber with 1/4" tubing connected to the top. Attach a 1/4" globe valve with 3/4" hose connection at end of tubing, termination point to be within 6" of ceiling or access door or to nearest floor drain or as shown.

- a. Manual air vents shall be installed at high pints of piping system where piping offsets more than 6" from horizontal to vertical. Air vent bleed valves shall be easily accessible within arms reach at ceiling access.
- b. Air vents shall have the drain line run to a floor drain or floor sink. Above ceiling reheats shall have the air vent drain line drop down to within 3" of the ceiling or access door with a shut off valve. Must be within arms reach.

## 2.9 WATER RELIEF VALVES:

- A. Provide water relief valves as indicated, of size and capacity as selected by installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F and pressure relief at 125 psi.
- C. Pressure Relief Valves: Watts Series 740, or equal, bronze body, test lever, ASME rated. Provide pressure relief at 30 psi.
- D. Manufacturers: Armtrol, Inc.. Bell and Gossett ITT; Fluid Handling Division, Spirax Sarco, or equal.

### PART 3 – EXECUTION

### 3.1 INSPECTION:

- A. Examine areas and conditions under which hydronic piping systems and specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- 3.2 INSTALLATION OF VALVES:
  - A. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere as indicated or required to completely drain hydronic piping system.
    - 1. Hose bibs are not to be used as drain valves on low pint drains, equipment, etc.
  - B. Check Valves: Install on discharge side of each pump and elsewhere as indicated.

# 3.3 EQUIPMENT CONNECTIONS:

- A. Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return; drain valve on drain connection.
  - 1. Hose bibs are not to be used as drain valves on low pint drains, equipment, etc.
- 3.4 INSTALLATION OF HYDRONIC SPECIALTIES:
  - A. Balance Valves: Install balance valves on each hydronic terminal and elsewhere as indicated. After hydronic system balancing has been completed, mark each balance valve with stripe of yellow lacquer across body and stop plate to permanently mark final balanced position.
  - B. Vent Valves:

- 1. Manual air vents: At all high points, reheat coils, the air vent assemblies shall consist of a 1/4" sov and a 2" x 12" nipple air chamber with 1/4" tubing connected to the top. Attach a 1/4" globe valve with 3/4" hose connection at end of tubing, termination point to be within 6" of ceiling or access door or to nearest floor drain or as shown.
- 2. Automatic Vent Valves: Install automatic vent valves at top of each hydronic riser and elsewhere as indicated. Install shutoff valve between riser and vent valve, pipe outlet to suitable plumbing drain or as indicated.
- C. In-Line Air Separators: Connect inlet and outlet piping.
- D. Diaphragm-Type Expansion Tanks: Install diaphragm-type expansion tanks on floor as indicated, in accordance with manufacturer's instructions. Vent and purge air from hydronic system; charge tank with proper air charge as recommended by manufacturer.
- E. Chemical Feeders: Install in upright position with top of funnel not more than 48 inches above floor. Install globe valve in pump discharge line between recriculating lines. Pipe drain to nearest plumbing drain or as indicated.
- F. Water Relief Valves: Pipe discharge to floor drain or floor sink. Comply with ASME Boiler and Pressure Vessel Code.

# 3.5 INSTALLATION OF CHEMICAL TREATMENT SYSTEM:

- A. Comply with manufacturer's instructions for installation of chemical treatment system, except as otherwise indicated.
- B. Piping shall be initially cleaned, before start-up of any equipment, with a suitable cleaning agent introduced into the piping system as recommended by the manufacturer. This treatment shall be circulated for not less than 24 hours, followed by flushing until neutral. Refer to care and cleaning procedure. Temporary circulating pumps shall be furnished by Contractor. Project pumps shall not be used for this purpose. Condenser water shall not be circulated until chemicals are introduced into the piping system. All portions of piping shall be cleaned. Provide all necessary pipe fittings and piping to allow this to occur. Where tees and crossovers are required provide with flanges to allow removal of temporary piping.
- C. Provide test equipment to test conductivity by portable solids meter, range 9-2500 ppm; nitrite by drop test; pH in range of 5.5 to 8.5 by color comparator; alkalinity by titration.
- D. Secure the services of a water treatment specialist who will perform the following work:
  - 1. Supervise initial clean out of piping systems.
  - 2. Supervise installation of chemical feed equipment to assure that all water treatment work is properly installed. Coordinate locations of blowdown and injection points with contractor.
  - 3. Make water analysis and establish chemical and water balance to prevent corrosion and scale formation in the recirculating water.
  - 4. Instruct the Owner's personnel in the use and control of the chemical treatments supplied.
  - 5. After completion of work, submit recirculating water analysis and certification to Owner's Representative that all work has been performed in accordance with Drawings and specifications.

6. Provide a one-year's supply of the required chemicals to the Owner at the completion of the job. All open loop systems shall be inspected on a monthly basis. Closed loop systems shall be inspected quarterly. Each inspection shall consist of analytical laboratory services to test the water. Test shall include microbiological testing and corrosion rate testing, and shall ensure proper water chemistry for systems. Provide report for each test to owner and engineer.

## 3.6 FIELD QUALITY CONTROL:

- A. Test hydronic piping in accordance with testing requirements of Division-23 Basic Mechanical Materials and Methods sections.
- 3.7 ADJUSTING AND CLEANING:
  - A. Clean, flush, and inspect hydronic piping systems in accordance with requirements of Division-23 Basic Mechanical Materials and Methods sections.
  - B. Strainers: Remove all strainer baskets after system flush and prior to equipment start up.

# 3.8 CARE AND CLEANING:

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Owner's Representative. At completion, carefully clean and adjust equipment and trim installed as part of this work. Leave systems and equipment in satisfactory operating condition.
- B. After all equipment has been installed complete, the piping systems shall be cleaned as follows:

Add a solution of alkaline cleaner to the manufacturers recommended dosage. Circulate the system for 24 hours. Standby pumps should operate 50% of the circulation time, while all other pumps should operate 100% of the time. After 24 hour circulation time the system shall be drained, filled and operated repeatedly until clean and free of dirt and debris. Water quality should be that of incoming make-up water quality, and clarity should be clear. All strainers at pumps, control valves, and wherever else they are installed in the system shall have mesh elements removed, cleaned and/or replaced repeatedly until system can operate continuously without any dirt buildup on strainer elements.

Provide passivation by pretreatment chemical prior to filling. Circulate for 48 hours. Flush with water until proper phosphate levels are achieved. Removal and clean all strainers after passivation.

For closed loops add a corrosion inhibitor per manufacturers recommendations and dosage to maintain a Nitrite level (NO2) of the following: Chilled water loops: 300-500 ppm NO2 Heating hot water loops:500-800 ppm NO2

### 3.9 OPERATION TEST:

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.
- 3.10 CLEANING UP:
  - A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

# END OF SECTION

# SECTION 23 22 13

## STEAM SYSTEMS AND EQUIPMENT

### PART 1 - GENERAL

### 1.1 WORK INCLUDED:

A. Types of steam systems and equipment specified in this Section include the following:

Steam Piping Condensate Piping Steam Traps and Drip Sets Pressure Reducing Valves Condensate Receiver and Pump Unit

### 1.2 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of steam and condensate piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Requirements of Regulatory Agencies:
- C. ASME Compliance: Fabricate and install steam and condensate piping in accordance with ASME B31.9 "Building Services Piping."
- D. UMC Compliance: Fabricate and install steam and condensate piping in accordance with IAPMO "Uniform Mechanical Code."

# 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of steam and condensate pipe.
- B. Record Drawings: At project closeout, submit Record Drawings of installed piping systems, in accordance with requirements of Division 1.

# PART 2 – PRODUCTS

# 2.1 MATERIALS:

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on steam and condensate piping systems maximum design pressures or as specified. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in steam and condensate piping systems.

### 2.2 BASIC PIPES AND PIPE FITTINGS:

- A. Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings," in accordance with the following listing:
- B. Steam Piping at 15 Psig and below: ASTM A53 black steel Schedule 40. Pipe sizes 2 inches and smaller Schedule 80 black steel pipe with wrought-steel, buttwelding fittings. On pipe sizes 2-1/2 inches and larger, standard-weight, full-radius, butt-welding fittings and weld neck flanges.

- C. Steam Piping above 15 Psig: ASTM A53 black steel Schedule 40. Provide wrought-steel buttwelding fittings for all pipe sizes.
- D. Condensate Return and Pumped Condensate Piping: ASTM A53 or ASTM A120 black steel Schedule 40. On pipe sizes 2 inches and smaller 125-lb., cast-iron, threaded, steam pattern fittings.
- E. Steam and Condensate Return Piping Below Grade: Encased in prefabricated insulated piping system as manufactured by Perma-Pipe Co., or equal, no known equal. Piping shall be all welded construction. Insulation shall be 2-1/2" thick calcium silicate. Casing shall be 10 gauge black steel with all welded seams. All fittings shall be prefabricated and assembled by manufacturer. Field joints shall be made as follows: Join inner and outer pipes together by welding; cover bare pipe section with matching half sections of insulation; cover casing seams with conduit closure sleeve supplied with piping, and weld all joints and seams. Complete installation shall be as recommended by manufacturer, including terminals, anchors, etc. Manufacturer's field representative shall be present at unloading and for all critical phases of piping installation, such as making field joints, and at final inspection of piping, before backfilling of trench.

# 2.3 STEAM TRAPS AND DRIP SETS:

- Provide steam traps and drip sets as shown on Drawings and as specified herein. Size traps in accord with required capacities and pressure differentials given on Drawings. Equip traps with ASTM A278 Class 30 cast iron bodies, chrome steel valves and stainless steel seats.
- B. Manufacturers: Armstrong, Sarco or equal.
- 2.4 PRESSURE REDUCING SETS:
  - A. Complete with valves, strainers, gauges and fittings.
  - B. Reducing valves for steam service shall have self-contained control, dual diaphragms with pilot, single seated, normally closed type. Valves, seats and springs: Stainless steel. Diaphragms: Stainless Steel 300 Series. Valve bodies: Cast-Iron. All valves shall be suitable for maximum operating conditions of 250-psig and 450 degress F. Valves: Leslie Class GPKP-1 or equal.

# 2.5 CONDENSATE RECEIVER AND PUMP UNIT:

- A. General: Provide as indicated, condensate receiver and pump unit, of capacity as scheduled, consisting of cast-iron receiver, inlet strainer, 2 water pumps, and accessories as specified herein. Factory-test complete unit and furnish certified test report including NPSH characteristics.
- B. Receiver: Construct of close grained cast iron and equip with water level gage, dial thermometer, pressure gage for each pump discharge, isolation valves between pump suction and receiver, and 2 lifting eye bolts.
- C. Control Panel: Provide NEMA 2 control panel mounted on receiver, factory-wired, and enclosing the following:
  - 1. Combination magnetic starters for each pump, with 3 overload relays, circuit breaker and cover interlock.
  - 2. 2 selector switches.
  - 3. Momentary contact "test" push button for each pump.

- 4. Circuit breaker for control circuit with cover interlock.
- 5. Fusible control circuit transformer for each circuit when motor voltage exceeds 130v.
- D. Manufacturers: Paco Pumps, Peerless Pump, or equal.

# PART 3 – EXECUTION

- 3.1 INSTALLATION OF STEAM AND CONDENSATE PIPING:
  - A. Steam Piping:
    - 1. Where possible, install piping with 1/16-inch per foot (1/2 percent) downward slope in direction of steam flow. Otherwise, install with 1/32-inch per foot (1/4 percent) downward slope.
    - 2. Install branch piping and riser offsets with 1/8-inch per foot (one percent) downward slope in direction of condensate return.
    - 3. Install eccentric reducer where pipe is reduced in size, with bottoms of both pipe and reducer flush. Locate reducers 18-inch minimum distance from branch connection.
  - B. Condensate Piping:
    - 1. Install condensate piping to return steam condensate collection. Comply with applicable steam piping installation requirements, except install piping with 1/32- inch per foot (1/4 percent) downward slope in direction of flow.
- 3.2 FABRICATION AND INSTALLATION OF PIPING COMPONENTS:
  - A. General: Fabricate and install piping components in accordance with applicable requirements of Division-23 sections, ASME B31.9, and, where not otherwise indicated, comply with recognized industry practices to ensure that components serve intended function.
- 3.3 FIELD QUALITY CONTROL:
  - A. Test steam and condensate piping in accordance with testing requirements of Division-23 Basic Mechanical Materials and Methods sections.
- 3.4 ADJUSTING AND CLEANING:
  - A. Clean, flush, and inspect steam and condensate piping systems in accordance with requirements of Division-23 Basic Mechanical Materials and Methods sections.

### END OF SECTION

# SECTION 23 74 13

# AIR HANDLING UNITS

# PART 1 – GENERAL

## 1.1 SECTION INCLUDES

Design, performance criteria, controls, and installation requirements for Custom Air Handling Units.

## 1.2 REFERENCES

- A. AMCA Standard 99: Standards Handbook
- B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
- C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
- D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
- E. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters
- F. AHRI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
- G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
- H. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems
- I. UL Standard 1995: Heating and Cooling Equipment
- J. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

### 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Division 1.
- B. Submittals shall include the following:
  - 1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
  - 2. Summary of all auxiliary utility requirements such as: electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.
  - 3. Ladder type schematic drawing of the power and ancillary utility field hookup requirements, indicating all items that are furnished.
  - 4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
    - a. Input data used for selection.
    - b. Model number of the unit.

- c. Net capacity.
- d. Rated load amp draw.
- e. Noise levels produced by equipment.
- f. Fan curves.
- g. Approximate unit shipping weight.

# 1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and Maintenance manuals shall be submitted at the time of unit shipment.

## 1.5 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom HVAC equipment. Manufacturer shall have been in production of custom HVAC equipment for a minimum of 5 years.
- B. Each unit shall bear an ETL or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL or UL listing of individual components, or control panels only, is not acceptable.
- C. OSHPD Listing Preapproval Number OSP-0576-10
  - 1. Equipment shall carry the OSHPD pre-approval (OSP) label and have had similar equipment tested and analyzed in accordance with ICC AC-156 and ASCE 7-05, using shaker table testing. Seismic certification must be provided through a certified seismic qualification agency with 3<sup>rd</sup> party accreditation from the International Code Council.
  - 2. For OSHPD applications, manufacturer shall be pre-approved by OSHPD and shall have a current OSP number on file.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner.

### 1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

## 1.8 WARRANTY

- A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of start-up forms for the unit or eighteen months after the date of shipment, whichever occurs first.
- B. The installing contractor shall provide labor warranty during the unit's first year of operation.

### PART TWO - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide custom outdoor air handling units as manufactured by Temtrol as the basis-ofdesign.
- B. OSHPD Listing Preapproval Number OSP-0576-10
  - 1. Equipment shall carry the OSHPD pre-approval (OSP) label and have had similar equipment tested and analyzed in accordance with ICC AC-156 and ASCE 7-05, using shaker table testing. Seismic certification must be provided through a certified seismic qualification agency with 3<sup>rd</sup> party accreditation from the International Code Council.
  - 2. For OSHPD applications, manufacturer shall be pre-approved by OSHPD and shall have a current OSP number on file.

# 2.2 GENERAL

- A. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for outdoor application with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.
- 2.3 Factory Testing and Quality Control (Contact Factory for additional testing options; Leak, Deflection, Sound or Other)
  - A. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.

# 2.4 UNIT CONSTRUCTION DESCRIPTION

- A. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.
- B. Rigging Provision Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit.
  - 1. Factory supplied empty junction boxes mounted at each shipping split for electrical reconnection to be performed in the field by others.
- C. Unit Base Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on

maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16ga galvanized steel. The outer sub-floor of the unit shall be made from 20 ga galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

- D. Unit Casing The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 16 gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 16 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8" positive pressure). The air handling unit casing shall be of the "no-throughmetal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.
  - 1. Exterior unit casing to be factory painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95 degrees F. 2,500 hrs. and (ASTM D-2247) Humidity Resistance at 95 degrees F. 2,500 hrs. The color shall be sandstone.
    - a. <u>Note: If manufacturer cannot provide thermal break (no through metal)</u> and or removable exterior panel construction it must be noted as an exception on the bid.
- E. Double Wall Liner Each unit shall have double wall construction with 20 gauge solid galvanized liner in the entire unit. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.
- F. Insulation Entire unit to be insulated with a full 3" (R12.6) thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in. /sq. ft. F°) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.
- G. Access Doors The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built-in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
  - 1. <u>Note: If manufacturer cannot provide thermal break door design it must be noted</u> <u>as an exception on the bid.</u>
    - a. Access doors (in the fan section) shall be provided with a 10 x 10 dual thermal pane safety glass window.
#### 2.5 UNIT COMPONENT DESCRIPTION

- A. Fans All fans shall meet the air flow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300.
  - 1. FANS Direct Drive Plenum Fans (AHUs as scheduled with a single fan)
    - a. Units Tagged: AHU 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 & 20
    - b. Units Tagged: AH 7, 8, 11, 12, 14, 18, 21, 22, 23, 28, 29 & C
    - c. The fan shall include direct driven, arrangement 4 plenum fan constructed per AMCA requirements for the duty specified. Class I fans are not acceptable. Fan wheels shall be aluminum construction and rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor assembly shall include a minimum 14 gauge spun steel fan inlet funnel, and a G90 galvanized steel motor support plate and fan base with internal RIS isolation.
    - d. All motors shall be standard foot mounted type TEAO or TEFC selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Siemens, or Toshiba that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed L10-400.000 hr bearings with shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022" per second peak, filter in (.55mm per second peak, filter in).
  - 2. VFD Fan Control
    - a. ABB ACH-580 VARIABLE FREQUENCY DRIVE:
      - i. As required by system design, provide a single ABB ACH 580 Variable Frequency Drive to start and run all motors in the FANWALL Array. The Variable Frequency Drive shall be sized accordingly to start and hold all motors in the Fan Wall. Provide service disconnect with fuses or circuit breaker.
  - 3. Flow Monitoring System
    - a. As required by system design, a single fan in each fan section assembly shall be equipped with airflow monitoring probes. The flow measuring system shall consist of a flow measuring station with two static pressure taps and two total pressure tubes located at the throat of the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan

AIR HANDLING UNITS 23 74 13 - 5 and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator shall provide a:

- i. Output control signal transmitter (4-20mA) (0-10 volt) for use in BAS as specified elsewhere
- ii. Transmitter powered by others
- B. Fanwall Technology<sup>™</sup> (FWT) <u>AHUs as Scheduled with Multiple Fans</u>
  - 1. Units Tagged: AHU 24, 25, 26, 27, GSA, K
  - 2. Units Tagged: AH 1, 2, 3, 4, 5, 6, 10, 15, 19
    - The multiple fan array systems shall include direct driven, arrangement 4 a. plenum fans constructed per AMCA requirements for the duty specified class III as required. Class I fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10-gauge, G 90 Galvanized steel intake wall, motor support rail, .100 aluminum spun fan inlet funnel. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-500,000 hr) bearings and shaft grounding to protect the motor bearings from electrical discharge.
      - i. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022" per second peak, filter in (.55mm per second peak, filter in).
        - a. Fan and motor assemblies submitted for approval incorporating larger than 22" wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022" per second peak filter in (.55 mm per second peak, filter in). Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include a statement of compliance with this requirement will be returned to the contractor without review.
    - b. The multiple fan array AHU unit shall provide the specified acoustical performance as scheduled for the unit supply discharge opening(s), RA opening(s), and the OSA and Exhaust air opening(s). Listed or alternate manufacturers, other than the basis of design, providing multiple fan

AIR HANDLING UNITS 23 74 13 - 6 arrays that incorporate fans which are not manufactured by the AHU manufacturer, must provide modeled acoustical performance of the AHU unit for pre-bid approval by the engineer 10 working days before the project bid date. Submitted sound and performance data for preapproval showing only single fan performance for multiple fan arrays will be returned without review. Approved alternate or listed manufacturers that do not manufacture their own fans for the specific purpose of use in multiple fan arrays, shall provide a letter guaranteeing submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit signed by an officer of the OEM fan manufacturer being submitted on. The letter from the OEM fan manufacturer must clearly state that the submitted air handling unit perimeter boundary performance in the submitted AHU configuration is guaranteed, and that any deficiencies in performance from that as scheduled will be corrected at no cost to the owner.

- i. Submittals for listed and alternate manufacturers that do not contain the letter of guarantee as described above will be returned to the contractor disapproved and must be resubmitted for approval. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the owner to meet the specified performance criteria. All proposed corrective actions, when required, must be submitted for approval, and shall include a guarantee of performance, as listed above, at no additional cost to the owner.
- c. The fan array shall consist of multiple fan and motor "cubes" or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross sectional area of the AHU air way tunnel.
  - i. There shall be no blank off plates or "spacers" between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36" from the intake side of the fan array intake plenum wall, and at a distance of 72" from the discharge side of the fan array intake plenum wall.
  - ii. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for pre-bid approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
- 3. Integral Back Draft Damper Per Fan:
  - a. Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back-flow prevention device(s) shall be included in the

AIR HANDLING UNITS 23 74 13 - 7 criteria for TSP determination for fan selection purposes and shall be indicated as a separate line item SP loss in the submittals.

- i. Submitted AHU performance that does not indicate allowance for system effects for the back flow prevention device(s) and the system effect for the fan and motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all of the requested information included for approval.
- ii. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan.
- iii. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement "A" free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included. At the sole discretion of the engineer, such performance testing may be witnessed by the engineer and/or the owner's representative.
- 4. Each fan motor shall be individually wired to a control panel containing a single VFD as the primary VFD. Each VFD shall be sized for the total connected HP for all fan motors contained in the fan array. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements. When specified, the AHU unit manufacturer shall provide a single communication interface with the BAS and shall coordinate with the controls contractor to make sure that all necessary data points are communicated.
  - a. At the sole discretion of the engineer, AHU manufacturers that are approved for bidding purposes only, other than the basis of design manufacturer, and that are submitting multiple fan arrays, shall test one or more of the submitted AHU's for flow, pressure, leakage, BHP and acoustics as submitted and approved, prior to shipment. The testing shall be witnessed by an owner's representative and approved by the engineer prior to shipment of any of the submitted AHU equipment. A test report shall be provided for each tested AHU unit and the report shall be included in the O&M manuals for the units.
  - b. Each fan & motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor. All fan/motor access doors shall open against pressure.
- 5. Motor Circuit Protection:
  - a. All motors in the FANWALL Array shall be provided with individual Motor Protection for thermal overload protection. All motor circuit protectors can be in starting device enclosure or, if required by design, in a separate enclosure. Motor circuit protector enclosure must be located and mounted at a minimal distance from motors in the FANWALL Array.
    - i. Provide remote indication by means of aux contacts wired in series

- ii. Pilot Lights:
  - a. Multiple (one per fan) cover mounted pilot lights for local monitoring
- C. Fanwall Technology<sup>™</sup> (FWT) CONTROL:
  - 1. Variable Frequence Drive
    - a. As required by system design, provide a single ABB ACH 580 Variable Frequency Drive to start and run all motors in the FANWALL Array. The Variable Frequency Drive shall be sized accordingly to start and hold all motors in the Fan Wall. Provide service disconnect with fuses or circuit breaker.
- D. Flow Monitoring System:
  - 1. As required by system design, a single fan in each FanWall assembly shall be equipped with airflow monitoring probes. The flow measuring system shall consist of a flow measuring station with two static pressure taps and two total pressure tubes located at the throat of the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator shall provide a:
    - a. Output control signal transmitter (4-20mA) (0-10 volt) for use in BAS as specified elsewhere
    - b. Transmitter powered by others
- E. Heat Transfer Coils Chilled Water Coil
  - 1. All coil assemblies shall be leak tested under water at 315 PSIG and PERFORMANCE is to be CERTIFIED under AHRI Standard 410. Coils exceeding the range of AHRI standard rating conditions shall be noted.
  - 2. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.
  - 3. Headers are to be seamless copper with die formed tube holes.
  - 4. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
  - 5. Water coils shall have the following construction Standard 5/8" Coil:
    - a. 5/8" o.d. x .020" wall copper tube with .028 return bends.

- b. .008" aluminum fins
- c. 16 gauge 304 stainless steel casing
- F. Steam Coils
  - 1. Steam Coils to be factory installed on all AHUs as dictated on the mechanical schedules.
  - 2. Standard steam coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. Fins shall be die formed plate type. Headers shall be seamless copper with die formed tube holes. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass. Steam pressure above 50 PSIG will have opposite end connections. Maximum fin length of 120" with same end connections. Intermediate tube supports shall be supplied on coils over 44" fin length, with an additional support every 42" multiple thereafter. Standard construction shall be suitable for 25 PSIG steam pressure.
  - 3. Standard steam coils shall have the following construction:
    - a. 5/8" o.d. x .025" wall tube. (25 psig maximum steam pressure)
    - b. .008" aluminum fins
    - c. 16 gauge 304 stainless steel casing
- G. Condensate / Drain Pans IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail.
- H. Filters Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall follow ANSI/UL 900 Test Performance of Air Filters.
  - 1. Filter Gauge: Each Filter bank shall be furnished with: Magnehelic filter gauge with a 4 <sup>3</sup>/<sub>4</sub>" OD white static pressure dial with black figures and zero pointer adjustment Dwyer Series 2000.
  - 2. Flat Racks Filter racks shall be completely factory assembled and designed for industrial applications. Filter racks shall be fabricated from no less than 16 gauge galvanized steel. Filter racks shall be applied in low efficiency filter applications and will be either upstream or side accessible. Side accessible filter racks shall have an oversized access door on the exterior of the air handler, centered on the filter rack for easy filter removal. Upstream access filter racks shall have one central access cover per row of filters centered in the unit for easy access. Filter racks over 72" in length shall require an angle center reinforcement support. Filter racks shall be designed for a maximum of 500 fpm or meet or exceed the area specified in the mechanical schedule.
  - 3. Pre-Filters As specified in the mechanical schedule.

a. Medium Efficiency Pleated Filters - Filters shall be 2" thick, MERV 8 efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25-30% and an average arrestance of 90-92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area and shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm approach shall not exceed 0.28" wg.

- 4. Final Filters As specified in the mechanical schedule and drawings.
  - a. High Efficiency Box Filters Filters shall be 4" thick, MERV 13 efficiency.
    - Filters of the size and air flow capacity shall meet the following rated performance specifications based on the ASHRAE 52.2 test method. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24" x 24" face dimension.
    - ii. The filters shall be UL Classified and Listed by Underwriters' Laboratories, Inc. when tested according to U. L. Standard 900 and CAN 4-S111.
    - iii. Each filter shall consist of a pleated media pack contained in a beverage board die cut frame. The filters shall be capable of operating at temperatures up to 150 degrees Fahrenheit.
    - iv. Frame
      - a. The frame shall be made of high wet strength beverage board. The two-mating die cut boxes shall be bonded together to contain the pleated media pack, and form a double wall for strength and protection. The inside of the filter frame shall be bonded to the pleated media pack on all four sides and at all points of contact across the front and rear faces of the filter.
    - v. Media
      - a. The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side.
    - vi. Separators
      - a. The media shall be pleated using separators made of beads of adhesive.
  - b. High Efficiency Rigid Filters Filters shall be 12" deep high performance, pleated, totally rigid and totally disposable type, MERV 13 efficiency.
    - i. Each filter shall consist of high density glass fiber media, media support grid, contour stabilizers and enclosing frame. Filter media shall be laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall have an average efficiency of MERV 13 The media support shall be a metal grid with an effective open area of not less than 96%. The metal grid

shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull-away. Filters shall be listed Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52.1-76. The filter shall be capable of withstanding a 10" wg pressure drop without noticeable distortion of the media pack. The enclosing frame shall be constructed of galvanized steel. The periphery of the filter pack shall be continuously bonded to the inside of the enclosing frame, thus eliminating the possibility of air bypass.

- I. Dampers Ruskin CD 60 or approved equal.
  - 1. Ratings:
    - a. Leakage: Damper shall have a maximum leakage of 3 cfm/sq. ft. @1 inch wg. and shall be AMCA licensed as Class 1A.
    - b. Size: Damper widths from 12 inches (305 mm) to 60 inches (1524 mm) meeting Class 1A as scheduled or required.
    - c. Differential Pressure: Damper shall have a maximum differential pressure rating of 13 in. w.g. (3.2 kPa) for 12 inches (305 mm) blades.
    - d. Velocity: Damper shall have a maximum velocity rating of 6,000 fpm (1,829 m/min).
    - e. Temperature: Damper shall be rated for -72 to 275 degrees F (-58 to 135 degrees C).
  - 2. Construction:
    - a. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel.
    - b. Blades:
      - i. Style: Airfoil-shaped, single-piece.
      - ii. Material: Minimum 14 gage (2.0 mm) equivalent thickness, galvanized steel.
    - c. Width: Nominal 6 inches (152 mm).
  - 3. Bearings: Self-lubricating stainless-steel sleeve, turning in extruded hole in frame.
  - 4. Seals:
    - a. Blade: Extruded Ruskiprene TPV type for ultra-low leakage from -76 to 350 degrees F (-60 to 177 degrees C). Mechanically attached to blade edge.
    - b. Jamb: Flexible metal compression type.
  - 5. Linkage: Concealed in frame.
    - a. Axles: Minimum 1/2 inches (13 mm) diameter plated steel, hex-shaped, mechanically attached to blade.

- b. Mounting: Vertical.
- 6. Multizone Dampers.
  - a. For use on AH-24, 25, 26, 27, & GSA
  - b. Notes:
    - i. This damper, mounted on the discharge of air-handling units, distributes conditioned air to numerous zones with a building.
    - ii. Each zone can be sized for a specific CFM volume.
    - iii. Each zone is controlled by a single actuator.
    - iv. Heated and cooled air are never discharged simultaneously.

#### c. Construction:

- i. Frame:
  - a. 16 ga. galvanized steel channel, 1"x12"x1".
- ii. Deck Dividers:
  - a. 16 ga. galvanized steel tube, 1"x9 ½", Insulated.
- iii. Blades:
  - a. Each of the three blades (hot deck, cold deck, and bypass) is 16 ga. galvanized steel, formed to fit the shafts and to add straightness and strength. The standard blade width is 8".
  - b. Using combinations of 8", 7", 6", 5", 4", and 3" as necessary to fit the desired zone-size requirements.
- iv. Shafts:
  - a. A plated steel shaft, 1⁄2" diameter is continuous across each segment and extends 6" beyond the inside dimension of frame at either the hot deck or the cold deck side (to be specified). The hot and cold deck blades ride on galvanized steel hollow shafts at .87" outside diameter, concentric with the full-length shaft and spring loaded to the closed position.

#### v. Springs:

- a. Torsion springs are accessible at both sides of the damper. They are factory set at the optimum torque position and are replaceable.
- vi. Bearings:
  - a. All shafts are supported by sintered bronze, oil impregnated bearings. The blades and shafts are

provided with thrust bearings to allow the damper and shafts to be in a vertical position.

- vii. Seals:
  - a. All blade ends are sealed at the jambs and deck dividers with neoprene foam seals. All blade edges are sealed using flexible extruded shapes.
- viii. Duct Cleats:
  - a. Galvanized steel "S" cleats are provided on the discharge side of the damper, between all blades (except only at duct locations if zone sizes have been indicated).
- ix. Linkage:
  - a. All blades will be inter-linked on the extended shaft (actuator) side of the damper. The linkage rod will then be cut in the field to arrange zones as needed.
  - b. If no individual zone-sizes have been indicated, all blades will be inter-linked on the extended-shaft (actuator) side of damper. The linkage rod can be field cut to arrange zones.
- d. Sequence of Operation:
  - i. The by-pass is attached to the full length  $\frac{1}{2}$ " diameter shaft. The hot deck and cold deck blades are mounted on (hollow) shafts that ride on bearings supported on the  $\frac{1}{2}$ " shaft. They are spring loaded to the closed position and are opened by levers attached to the  $\frac{1}{2}$ " shaft.
  - ii. The center (by-pass) blade is attached to the full-length  $\frac{1}{2}$ " diameter shaft. The hot deck and cold deck blades (at either side of the by-pass) are secured to larger hollow shafts that ride on bearings supported by the  $\frac{1}{2}$ " diameter shaft. They are spring-loaded to the closed position and are opened by a lever attached to the  $\frac{1}{2}$ " diameter shaft.
  - A full sequence of control occurs during 90 degrees of rotation by the ½" diameter shaft. The sequence given is clockwise (facing the shaft end) when actuated from either side of the damper
  - iv. When the point of rotation is 0 degrees:
    - a. The near deck is open. The bypass deck is closed. The far deck is closed.
    - b. The nearest deck is open. The by-pass deck is closed. The farthest deck is closed.
  - v. When the point of rotation is 0 to 45 degrees:
    - a. The near deck closes as the bypass deck opens.

- b. The nearest deck closes as the by-pass deck opens.
- vi. When the point of rotation is 45 degrees:
  - a. The near deck is closed. The bypass deck is open. The far deck is closed.
  - b. Nearest deck is closed. The by-pass deck is open. The farthest deck is closed, this is a normal position for all shafts when no rotational forces are applied. It is the position the blades would be in when the temperature of the zone is at set point.
- vii. When the point of rotation is 45 to 90 degrees:
  - a. The bypass deck closes as the far deck opens.
  - b. The by-pass deck closes as the farthest deck opens.
- viii. When the point of rotation is 90 degrees:
  - a. The near deck is closed. The bypass deck is closed. The far deck is open.
  - b. The nearest deck is closed. The by-pass deck is closed. The farthest deck is open.

#### e. Performance:

- i. Blade rotation allow linear control.
- ii. Each zone is controlled by a single actuator.
- iii. Air from the hot deck and the cold deck cannot simultaneously enter the duct.
- iv. The closed blades are tightly sealed on all four sides.
- v. The open blade provides unobstructed air flow resulting in low pressure drop.
- vi. Leakage less than 6 CFM per square foot of discharge face area at 4" SPWG.
- vii. Operating Torque: The following minimum torque applications are recommended:
  - a. Each single-shaft zone: 20 inch-pounds
  - b. Add for each additional shaft: 15 inch-pounds
- viii. Thermal limitation: -20 degree to +140 degree. Notify factory if hot deck temperature will exceed 140 degrees F.
- J. AIR MONITORING STATIONS:
  - 1. Paragon OAFE Airflow Measuring Station
    - a. <u>Air Handler Tags: AHU-9, AH-22 & AH-28 only</u>

- b. Provide airflow measurement system for monitoring and controlling minimum outdoor airflow rate.
- c. Basis-of-Design Product: Subject to compliance with requirements, provide Paragon Controls Inc., Model OAFE-1550 or equal as approved by the Engineer.
- d. Measure minimum amount of outside air as recommended by ASHRAE 62.1-2010, Ventilation for Acceptable Indoor Air Quality, and provide input to building automation system linear to measured airflow rate.
- e. Tested in accordance with AMCA 610, Figure 4, Methods of Testing Airflow Measurement Stations for Rating, and AMCA 611, Certified Ratings Program – Airflow Measurement Performance, in an AMCAregistered testing facility and bear the AMCA International Certified Ratings Seal for Airflow-Measurement Station Performance.
- f. Accurate to plus or minus 0.5 percent over operating range of 200 to 1,200 fpm (1 to 6 m per second), and within plus or minus 5 percent for operating ranges as low as 100 fpm (0.5 m per second).
- 2. Ruskin Measuring Louver Model AML3
  - a. Air Handler Tags using Ruskin AML3 OA Measuring Louver: <u>ALL</u> <u>REMAINING AH's and AHU's other than AHU-9, AH-22 & AH-28</u>
  - b. Fabrication: Sightproof/Mullion blade style.
    - i. Frame: 3 inch Depth
      - a. Material: Extruded aluminum, Alloy 6063-T6.
      - b. Wall Thickness: .062 inch (1.6 mm), nominal.
    - ii. Blades: Vertical sinusoidal.
      - a. Material: Extruded aluminum, Alloy 6063-T6.
      - b. Thickness: 0.040 inch (1.0 mm), nominal.
      - c. Centers: 3/4 inches (19 mm), nominal.
    - iii. Fabrication:
      - a. Mullion Style Design incorporates visible mullions or frames at the perimeter of the louver and at certain intervals within the louver perimeter to support the louver blades. Louver blade sightlines are interrupted at the mullion locations.
      - Louver design shall limit span between visible mullions to 120 inches (3048 mm) and shall incorporate integral structural supports to withstand a wind load of 25 psf (1.20 kPa).
  - c. Air Monitoring Device: AMCA Standard 611-95 for Airflow Measurement Station Testing.

- i. The airflow measuring blades are positioned vertically behind the louver blades and measure air velocity pressure. Air tubing/piping connections provided carry the velocity pressure from the sensing blades to a factory supplied low pressure transducer.
  - a. Ruskin Model RU 274.
- ii. Minimum airflow through free area: 345 fpm (1.4 m/s).
- iii. Maximum airflow through free area: 1400 fpm (7.0 m/s).
- iv. Operating Temperature: -22 degrees F to +140 degrees F (-30 degrees C to +60 degrees C) standard.

#### d. Performance Data:

- i. Performance Ratings: AMCA licensed.
  - a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.
- ii. Free Area: 45 percent, nominal.
- iii. Free Area Size: 5.18 sf (0.48 sm).
- iv. Maximum Recommended Air Flow through Free Area: 1409 feet per minute (7.0 m/s).
- v. Air Flow: 7294 cubic feet per minute (206 cu. m/min).
- vi. Maximum Pressure Drop: 0.20 inches w.g. (49.78 Pa).
- vii. Wind Driven Rain Resistance: Based on testing 39 inch by 39 inch (1. m by 1. m) core area, 41 inch by 41 inch (1.04 m by 1.04 m) nominal size unit in accordance with AMCA 500-L.
  - a. 29 mph (46.4 kph) wind velocity, 3 inches/hr (76 mm/hr) rainfall rate.
  - b. Core Velocity: 691 fpm (3.5 m/second).
  - c. Water Resistance Effectiveness: 100 percent (AMCA Class A)
  - d. Discharge Loss Classification (Intake Test): Class 1 (0.4 and above
- K. Louvers:
  - 1. Exhaust Air applications Model: ELF375DX as manufactured by Ruskin Company or approved equal.
    - a. Design:
      - i. Stationary drainable louver type with drain gutters in each blade and head with downspouts in jambs and mullions with all welded construction. Hidden vertical supports to allow continuous line

appearance up to 120 inches (3,048 mm). Steeply angled integral sill.

- b. Frame:
  - i. Frame Depth: 4 inches (102 mm).
  - ii. Wall Thickness: 0.081 inch (2.1 mm), nominal.
  - iii. Wall Thickness: 0.125 inch (3.2 mm), nominal.
  - iv. Material: Extruded aluminum, Alloy 6063-T6.

#### c. Blades:

- i. Style: Drainable. 37.5 degrees at 5-3/32 inches (129 mm), nominal.
- ii. Wall Thickness: 0.081 inch (2.1 mm), nominal.
- iii. Wall Thickness: 0.125 inch (3.2 mm), nominal.
- iv. Material: Extruded aluminum, Alloy 6063-T6.
- d. Recycled Content: 18% post-consumer. 55% pre-consumer, postindustrial, total 73% by weight.
- e. Performance Data:
  - i. Based on testing 48 inch x 48 inch (1,219 mm x 1,219 mm) size unit in accordance with AMCA 500.
  - ii. Free Area: 54 percent, nominal.
  - iii. Maximum Recommended Air Flow through Free Area: 873 feet per minute (4.4 m/s).
- 2. Outside Air applications RUSKIN AML3 extruded aluminum louvers shall be used at O/A location per the above spec section.
  - a. Louvers shall be stationary, drainable type with built in downspouts and furnished with birdscreen. Blades shall be vertical and housed inside an aluminum frame mounted to the unit exterior. Louver finish to match exterior unit finish.

#### 2.02 ELECTRICAL POWER AND CONTROLS

- A. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by OTHERS.
- B. All wiring shall be (75°C) Insulated copper wires.
- C. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.
- D. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtite flexible metal conduit may be used outside the air tunnel for wet locations.

- E. The unit shall feature a main non-fused disconnect in an individual electrical panel or at VFD panel, disconnect shall be of the proper amp rating to allow shutoff of all electrical motors and control items.
  - 1. <u>Single-Point</u> high voltage power (1) connection per each AHU
- F. Unit Convenience Features
  - 1. Each section (specified sections) shall be equipped with a vapor- proof 23-watt compact fluorescent service light with guard.
  - 2. Lights shall be controlled by one light switch mounted on unit exterior.
  - 3. Furnish a 120 volt GFI duplex convenience outlet on the exterior of the unit as indicated on the unit drawing.

#### END OF SECTION

# SECTION 26 00 00

## COMMON WORK RESULTS FOR ELECTRICAL WORK

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. The intent of the Division 26 Specifications and Drawings is to replace the facility roof with complete systems as shown, specified, and required by applicable codes. Furnish, and install all necessary labor, materials, tools, and equipment to complete the work specified in these Specifications and shown on the Drawings.
- B. This section applies for all Division 26 electrical sections. All conditions and materials are pertinent to the other sections as if repeated in those sections.
- C. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
- D. Use the more stringent requirement when specified materials or methods exceed the applicable codes or standards.
- E. The Drawings that accompany the Division 26 Specifications are diagrammatic. They do not show every offset, bend, conduit body, elbow or junction box that may be required to install work in the space provided and avoid conflicts. Follow the Drawing as closely as is practical and install additional bends, offsets and elbows where needed by local job site conditions. Provide necessary junction boxes to meet code regulations for the allowed number of conduit bends. The right is reserved to make minor field order changes within 12 inches in outlet location prior to pre-fabrication/roughing-in without additional cost to the owner.
- F. Division 1, General Requirements apply to this Division.

## 1.2 CODES AND STANDARDS

- A. Publications and standards listed below form a part of this specification to the extent referenced. The publications and standards are referred to in the text by basic designation only.
  - 1. 2019 California Administrative Code (CAC) Part 1, Title 24, CCR
  - 2. 2019 California Building Code (CBC) Part 2, Title 24, CCR
  - 3. 2019 California Electrical Code (CEC) Part 3, Title 24, CCR
  - 4. 2019 California Energy Code (CEnC) Part 6, Title 24, CCR
  - 5. 2019 California Fire Code (CFC) Part 9, Title 24, CCR
  - 6. 2019 California Existing Building Code (CEBC) Part 10, Title 24, CCR
  - 7. NFPA As adopted by State Agencies
    - a. 2016 NFPA 72
    - b. 2018 NFPA 99.
  - 8. California Occupational Safety Health Act (CAL-OSHA).
  - 9. All applicable State and Local Codes, Regulations, Laws, and Amendments.
- 1.3 SUBMITTALS

A. Provide product data submittals and shop drawings to the Engineer for review and acceptance prior to Work.

## 1.4 QUALITY ASSURANCE

- A. Nothing in the Contract Documents shall be construed to permit Work not conforming to applicable codes, laws, ordinances, rules, or regulations.
- B. Provide materials, equipment and accessories that are new and free from defects.
- C. Provide materials and apparatus that comply with NEC, NEMA, and ANSI standards.
- D. Material and equipment shall bear the UL label where such label is applicable or by a nationally recognized testing agency approved by the Authority having Jurisdiction.

## 1.5 WARRANTY

- A. Repair or replace any defective work, materials or part which may appear within 1 year of the date of acceptance. This shall include damage by leaks.
- B. On failure to comply with the above guarantee within a reasonable length of time after notification is given, the Architect shall have the repairs made at the Contractor's expense.

### 1.6 RECORD DRAWINGS

- A. Maintain up to date record set of electrical prints during construction. The prints re subject to monthly review by the owner's representative to ascertain that they are current. If not current, monthly payments may be withheld.
- B. Provide record Drawings that fully represent installed conditions including actual location of outlets, true panel board connections following phase balancing routines, correct conduit and wire sizing as well as routing for feeder and branch homeruns, diagrammatic branch circuit wiring, revised fixture schedule listing actual manufacturer and products installed, and revised panel board schedules.
- C. At the completion of the Work, incorporate all as-built changes to the Contract Documents and shop drawings via AutoCAD or other approved software application.

## 1.7 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Instruct the Owner's authorized representatives in operation, adjustment and maintenance of all electrical equipment and systems. Provide three copies of certificate signed by Owner's representatives attesting to their having been instructed.
- B. Furnish three complete sets of operating and maintenance instructions bound in a hardback binder and indexed. Start compiling the data upon approval of list of materials. Final observation will not be made until booklets are approved by the District.

C. Furnish one CD electronic copy of the maintenance instructions in PDF format.

# PART 2 - PRODUCTS

#### 2.1 GENERAL

- Α. All equipment to be installed or permanently connected (hardwired) shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL).
- B Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in good condition.
- C. Refer to applicable Division 26 Sections for complete product specifications.

#### 2.2 SUBSTITUTIONS

- Products or systems specified as "no substitutions": Provide as specified. Α.
- B. Products or systems noted as "or approved equal": A product or system of equivalent design, construction and performance will be considered. Submit all pertinent data and product information for review. Provide the Specified products or systems if proposed equivalent is found unacceptable.
- C. Acceptance of a substitution is not to be considered a release from the Specifications. Correct any deficiencies in an item, even though approved, at Contractor's expense.
- D. Be responsible for installation of approved substitution. Make any changes required for installation of approved substituted equipment at no increase in Contract Sum.

#### 2.3 DELIVERY AND STORAGE

Α. All equipment and materials delivered to site shall be protected from the weather. humidity and temperature variations, dirt and dust and other contaminants.

## PART 3 - EXECUTION

#### 3.1 COORDINATION OF WORK

- A. Conduct work in a manner to cooperate with all other trades for proper installation of all items of equipment. Consult the Drawings of all other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, in general, the architectural drawings govern but resolve conflicts with the Architect prior to rough-in.
- Β. Verify the physical dimension of each item of electrical equipment to fit the available space. The Contractor is responsible for coordinating electrical equipment space requirements with the allotted space provisions, and access routes through the construction area.
- C. Coordinate rough-in and wiring requirements for all equipment provided by other trades requiring electrical connections. Make installation in accordance with rough-in and wiring diagrams provided for Contractor's use.

D. Coordinate underground work with other contractors working on the site. Perform coordination with contractors installing storm sewer, sanitary sewer, water and irrigation lines, to avoid conflicts. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained. To the extent possible, locate electrical conduits and duct banks aside from plumbing and hydronic piping in common trench.

# 3.2 CONNECTIONS TO EXISTING WORK:

- A. Install new work and connect to existing work with minimum interference to existing facilities.
- B. Provide temporary shutdowns of existing services only with written consent of Owner. Perform this work at no additional charges and at times that do not interfere with normal operation of existing facilities.
- C. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
- D. Do not interrupt alarm and emergency systems without consent of owner.
- E. Connect new work to existing work in neat and acceptable manner.
- F. Restore existing disturbed work to original condition including maintenance of wiring and continuity as required.
- G. Provide temporary electrical power to temporary facilities as shown on the plans

## 3.3 DEMOLITION:

- A. Disconnect, remove, or relocate electrical material, equipment and other work as required by removal or changes in existing construction.
- B. Provide new material and equipment required for relocated equipment.
- C. Disconnect load and line end of conductors feeding existing equipment.
- D. Remove conductors from existing raceways to be rewired.
- E. Remove conductors and cap outlets on raceways to be abandoned.
- F. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
- G. Remove conductors back to nearest power source, junction box or panel board.
- H. Provide new type written panel board directories.
- I. Dispose of removed raceways and wire.
- J. Turn over removed electrical equipment to Owner as directed. Dispose of unwanted equipment and accessories.

### 3.4 INSTALLATION

- A. Provide a complete properly operating system for each item of equipment installed under this work. Installation in accordance with equipment manufacturer's instructions, the best industry practices, and the Contract Documents.
- B. Make installation in a neat, finished, and safe manner, according to the latest published NECA Standard of Installation under competent supervision.
- C. Review shop Drawings for work done by other trades.
- D. Verify all dimensions by field measurements.
- E. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in place concrete and other structural components as they are constructed.
- G. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
- H. Attempt to install systems, materials, and equipment to provide the maximum headroom possible and for maximum usability and clearances.
- I. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Any rearrangement or relocation of electrical work that blocks required access shall be performed at no additional cost to the Owner.
- K. Coordinate electrical systems, equipment, and materials installations with other building components.
- L. Coordinate the installation of access panels where devices or equipment are concealed behind finished surfaces. Arrange with General Contractor to provide properly sized access panel.
- M. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

## 3.5 FIRE WALL PENETRATIONS

A. Perform necessary fire rated wall and floor sealing for the electrical work in compliance with the 2019 California Building Code. Penetrations of pipes, conduits, etc., in walls and floors requiring protected openings shall be fire stopped. Fire stop materials shall be a tested assembly approved by the State Fire Marshal.

### 3.6 EQUIPMENT CONNECTIONS

- A. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, raceways, devices, and labor necessary for a finished working installation. This shall include all owner-furnished equipment and furniture systems as well as equipment furnished under other divisions of the Contract.
- B. Verify the location and method for connecting to each item of equipment prior to roughing-in. Check voltage and phase of each item of equipment before connection.

## 3.7 EQUIPMENT SUPPORT

A. Perform necessary equipment seismic anchorage in compliance with the California Building Code and requirements of any local agency having jurisdiction. Support shall be per manufacturer's recommendation.

## 3.8 ALIGNMENT

- A. Install equipment level and plumb, parallel with structural building lines.
- B. Fit devices and outlets with neat, appropriate trims, plates or covers, without over-hanging edges, protruding corners, or raw edges, to leave a finished appearance.

## 3.9 CUTTING AND PATCHING

- A. Neatly patch and finish any surface damaged by this work to match adjacent construction surface conditions; for instance, repair surfaces where raceways pass through finished floors or walls. Clean and remove all dirt and debris. Perform this work to the satisfaction of the Architect and Owner.
- B. Where equipment installations or connections require the installation of an access panel, arrange with General Contractor to provide a properly sized and installed access panel similar to those used for mechanical equipment access.

### 3.10 PROTECTION OF WORK

- A. Protect all electrical work and equipment installed under this Division against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Keep electrical equipment covered or closed to exclude dust, dirt and splashes of plaster cement or paint and shall be free of all such contamination before acceptance. Keep enclosures and trims in new condition, free of rust, scratches, and other finish defects. If damaged, properly refinish and repaint in a manner acceptable to the Architect.

## 3.11 TITLE 24 COMPLIANCE FORMS

- A. Provide complete Title 24 compliance forms, as necessary.
- 3.12 STARTUP AND TESTING

COMMON WORK RESULTS FOR ELECTRICAL WORK

- A. Upon job completion, test systems and show that the equipment installed operates as designed and specified, free of faults and unintentional grounds. The system tests may be set up and done for coordination with construction phasing. Perform testing or system operational functions in the presence of the Architect or his representatives. Schedule work in advance and as directed by the Architect or his representatives.
- B. Provide a minimum of 1 journeyman electrician with required tools during testing or system commissioning work. Provide equipment factory representative for this work when needed.
- C. Provide testing and commissioning work for equipment and systems noted in Division 26 specifications and drawings, including but not limited to:
  - 1. Lighting system
  - 2. Power & Signal
  - 3. Panel Boards and Equipment
- 3.13 PROJECT CLOSEOUT
  - A. Special tools or safety equipment: Provide one of each tool or piece of safety equipment required for proper operation and maintenance of equipment installed under this work.
  - B. Keying: Provide two keys for each lock furnished under this work.

# END OF SECTION

## SECTION 26 05 13

#### MEDIUM-VOLTAGE CABLES AND ACCESSORIES

#### 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.
- B. Related Sections include the following:
  - 1. Division 01 Section "General Commissioning Requirements" for requirements necessary for participation in and compliance with commissioning requirements.
- C. Comply with PG & E Electrical and Gas Service Requirements (TD-7001M Greenbook) latest edition.

#### 1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

#### 1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

#### 1.4 ACTION SUBMITTALS

- A. All documentation associated with this contract including submittals, shop drawings, O&M manuals, and test reports shall be furnished as follows.
  - 1. Documents shall be submitted in a portable document format (.pdf) with high resolution images, properly rotated, with annotations indicating the exact product being proposed with the applicable options and accessories. The file shall be tabbed and include a table of contents.
- B. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
- C. Cable-pulling calculations indicating the maximum pulling tension of the cable will not be exceeded in PDF, MS Word, or MS Excel format. Provide calcs prior to cable installation.
- D. Dynamometer readings recorded during cable pulling in PDF, MS Word or MS Excel format per submittal schedule.
- E. Contractor shall submit with the shop drawings heat calculations for all underground feeders based on contractor determined underground routing and actual soil thermal resistivity measurements provided by the geotechnical consultant, concrete and backfill provider. Feeder shall maintain required load ampacity for connected equipment with a load factor of 100% and without exceeding 90 degrees C. Heat

calculations shall be reviewed and approved by the engineer before the underground installation begins.

- F. Qualification Data: For testing agency.
- G. Material Certificates: For each cable and accessory type, signed by manufacturers.
- H. Field quality-control test reports.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer of medium voltage electrical cable to perform the installation specified in this section. Cable splices, connectors and terminations shall be made by certified workman with a minimum of 5 years' experience in terminating the specific types of cable and cable accessories specified in this Section.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- C. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Each reel of cable furnished shall be newly manufactured, no more than 12 months old.
- G. Codes and Standards: Conform to the following Standards:
  - 1. California Electrical Code.
  - 2. Electrical components and/or systems shall be listed and labeled by a nationally recognized testing laboratory (NRTL) such as: UL, ETL, CSA, or FM; shall be labeled and/or listed as part of a UL-labeled assembly, or shall be evaluated by a third party acceptable to the authority having jurisdiction (AHJ) as suitable for the use intended. All labels shall be applied at the manufacturer's factory or facility prior to shipment.
  - 3. AEIC Association of Edison Illuminating Companies.
  - 4. AEIC CG5-2005 Underground Extruded Power Cable Pulling Guide.
  - 5. AEIC CS8-2007 Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV.
  - 6. IEEE C2-latest National Electrical Safety Code (NESC) Part 3: Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines.
  - 7. ASTM B496-04-2010 Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
  - 8. ICEA Insulated Cable Engineer's Association.

- 9. ICEA S-93-639 / NEMA WC 74-2006 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
- 10. ICEA S-94-649-2004 Standard for Concentric Neutral Cables Rated 5 Through 46 kV.
- 11. ICEA S-96-659 / NEMA WC71-1999 Standard for Non-Shielded Cables Rated 2001 5000 Volts for Use in the Distribution of Electric Energy.
- 12. ICEA S-97-682-2007 Standard for Utility Shielded Power Cables Rated 5 Through 46 kV.
- 13. IEEE
- [IEEE 48<sup>™</sup>-latest IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV Through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.]
- 15. IEEE 386<sup>™</sup>-latest IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V.
- 16. [IEEE 400.1<sup>™</sup>-latest IEEE Guide for Field Testing of Laminated Dielectric, Shielded Power Cable Systems Rated 5 kV and Above with High Direct-Current Voltage.]
- 17. [IEEE 404<sup>™</sup>-latest IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2,500V to 500,000 V.]
- 18. [IEEE 525<sup>™</sup>-latest IEEE Guide for the Design and Installation of Cable Systems in Substations.]
- 19. IEEE 576<sup>™</sup>-latest Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
- 20. [IEEE 835<sup>™</sup>-latest IEEE Standard Power Cable Ampacity Tables.]
- 21. NECA NEIS 600-2003 Recommended Practice for Installing and Maintaining Medium-Voltage Cable.
- 22. NETA InterNational Electrical Testing Association Inc.
- 23. NETA ATS-latest Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- 24. UL
- 25. [UL 510-latest UL Standard for Safety, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.]
- 26. UL 1072-latest UL Standard for Safety, Medium-Voltage Power Cables.
- H. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
- I. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

- J. Source Limitations: Obtain cables through one source from a single manufacturer. Obtain accessories/ terminations through one source from a single manufacturer.
- K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- L. Comply with IEEE C2 and NFPA 70.
- 1.6 DELIVERY, STORAGE, AND HANDLING
  - A. Deliver medium voltage cable on factory reels conforming to NEMA Standard WC 26
    Wire and Cable Packaging. Reels with unsealed cable ends will be recorded and rejected by the Owner's representative.
  - B. Store cables on reels on elevated platforms in a clean, dry location.
  - C. On receipt, inspect cable protective covering for evidence of damage during shipment. Report immediately to carrier if evidence of damage is found.
  - D. Accomplish unloading without contacting cable surface or protective wrap. If unloading by crane, use cradle supporting reel flanges or a shaft through arbor hole. If using a forklift, lift the reel at 90 degrees to flanges. Use forms long enough to make complete lifting contact with both reel flanges.
  - E. If using inclined ramp for unloading, use ramp wide enough to contact both reel flanges completely. Accomplish stopping of reels at bottom by using the reel flanges and not the surface of the cable.
  - F. Do not drop reels from delivering vehicle to ground.
  - G. Store reels on hard surface to prevent flanges from sinking into the earth and allow the weight of the reel and cable to rest on the cable surface.
  - H. Do not store reels in an area where construction equipment, falling or flying objects or other materials will contact the cable.
  - I. Store cable where chemicals or petroleum products will not be spilled or sprayed on the cable.
  - J. Store cable away from open fires or sources of high heat.
  - K. When a reel of cable is rolled from one point to another, check for and remove objects on surface that could contact or damage the cable surface or protective wrap. Roll reel in direction to prevent loosening of the cable on the reel.
  - L. Store cable according to manufacturer's recommendations, as a minimum. In addition, store cable in location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provisions for ventilation to prevent condensation and for protection from weather. If air temperature at the cable storage location will be below 5 degrees C, move cable to a heated (10 degrees C minimum) location. If necessary, properly store cable off site at Contractor's expense.
  - M. Seal cut cable ends using properly sized heat shrink cap to prevent moisture ingress to the internal part of the cable.

# 1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Owner's written permission.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cables:
    - a. Southwire Company.
    - b. General Cable Technologies Corporation.
    - c. Okonite Company (The).
    - d. Pirelli Cables & Systems NA.
    - e. Rome Cable Corporation.
  - 2. Cable Splicing and Terminating Products and Accessories:
    - a. Engineered Products Company.
    - b. G&W Electric Company.
    - c. MPHusky.
    - d. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
    - e. RTE Components; Cooper Power Systems, Inc.
    - f. Thomas & Betts Corporation/Elastimold.
    - g. 3M; Electrical Products Division.
- 2.2 CABLES
  - A. Cable Type: MV105.
  - B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.
  - C. Conductor: Copper.
  - D. Conductor Stranding: Compact round, concentric lay, Class B).
  - E. Strand Filling: Conductor interstices are filled with impermeable compound.
  - F. Conductor Insulation: Ethylene-propylene rubber (EPR).
    - 1. Voltage Rating: 5KV & 15 kV.
    - 2. Insulation Thickness: 133 percent insulation level.
  - G. Shielding: Copper tape, helically applied, with minimum of 25% overlap, over semiconducting insulation shield.
  - H. Cable Jacket: Sunlight-resistant PVC.
  - I. Shielded Cable Construction:

- 1. Stranded copper conductor.
- 2. Extruded semiconductor EPR screen or nonconductive stress control layer.
- 3. EPR insulation.
- 4. Extruded semiconductor EPR screen.
- 5. Copper tape shield.
- 6. Jacket.
- J. Temperature Ratings:
  - 1. 105 degree C. continuous rating.
  - 2. 140 degree C. emergency rating.
  - 3. 250 degree C. short circuit rating.
- 2.3 SPLICE KITS
  - A. Splicing of MV cables is not allowed without prior approval from Owner and Engineer.
  - B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
    - 1. Cold or Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer cold or heat shrink jacket.
    - 2. Pre-molded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

## 2.4 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
  - 1. Class 1 Terminations, Outdoors: Cold or Heat-shrink type with cold or heatshrink inner stress control and outer non-tracking tubes; multiple, molded, nontracking skirt modules; and two-hole compression-type copper connector.
  - 2. Class 1 Terminations, Indoors: Kit with stress-relief tube, non-tracking insulator tube, shield ground strap, two-hole compression-type copper connector, and end seal.

## 2.5 SEALING

A. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

## 2.6 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosionprotective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

## 2.7 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify that each conduit is ready to receive work. Use properly sized mandrel to determine if installed conduit is suitable for use.
- B. Verify field measurements are as shown on Drawings.
- C. Record field-measured lengths of cable and forward to the Contractor.
- D. Beginning of installation means Contractor accepts existing conditions.

## 3.2 PREPARATION

A. Thoroughly swab conduits and pipes to remove foreign material before pulling cables.

### 3.3 INSTALLATION

- A. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- B. Support cables according to Division 26 Section "Common Work Results for Electrical."
- C. MV Cables from separate power buses shall not be installed in common manholes, handholes, pullboxes, junction boxes or cable vaults. Each power bus shall have a separate, isolated installation so that a failure of one cable shall not affect any other bus.
- D. Install "buried-cable" warning tape 12 inches (305 mm) below surface and minimum of 24 inches above duct banks.
- E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- F. Splicing of MV cables is not allowed without prior approval from Owner and Engineer. Install cable splices at pull points and elsewhere as indicated; use standard kits.
- G. Install terminations at ends of conductor cable ends with standard kits.
- H. Install separable insulated-connector components as follows:
  - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
  - 2. Portable Feed-Through Accessory: Three.
  - 3. Standoff Insulator: Three.
- I. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
- J. Sealing: Provide temporary closure at terminations of conduits that have cables pulled. Seal spare conduits at terminations. Use sealing compound and plugs to

withstand at least 15-psig hydrostatic pressure. All exterior conduits penetrating the building shall be sealed after all conductors have been pulled.

- K. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- L. Identify cables according to Division 26 Section "Identification for Electrical Systems."
- M. Permanent splices are not allowed. All splices shall be made with separable connectors and shall occur only in vaults and pull boxes.
- N. All equipment terminations shall be made via two-hole bolted lugs or separable elbow connectors, as indicated.
- O. Install cable and terminations in accordance with IEEE Standard 576.
- P. Install cable and terminations in accordance with manufacturer's instructions and installation guidelines.
- Q. Avoid abrasion and other damage to cables during installation. Install cable as indicated on plan drawings and cable schedules.
- R. Pulling Conductors:
  - 1. Do not exceed manufacturer's recommended bending radius, maximum pulling tensions and sidewall pressure values.
  - 2. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
  - 3. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
  - 4. Pull cables using suitable cable-pulling equipment. Do not exceed cable-pulling tensions or minimum-bending radius recommended by manufacturer.
  - 5. Include approval of cable pull setup by Contractor and Owner prior to each pull.
  - 6. Where pulling equipment is attached to columns, structure, or strut framework, ensure maximum stress limitations of support and structure systems are not exceeded.
  - 7. During the pulling operation, use dynamometer to record the pulling tension. Give notice to Owner before cable is pulled so his representative can observe pull. Record dynamometer readings.
  - 8. Install cable using mechanical means with cable pulling equipment, pulleys, sheaves, wheel, and rollers. Use of hydraulic or electric pulling equipment with smooth, variable speed control is required. Do not manually pull in cables.
  - 9. Use correctly sized cable pulley (sheave) for each cable-pull. Size sheave diameter per cable calculations. Use sheave wide enough for cables to properly ride over the sheave. Do not use narrow sheaves. Set up sheaves for direct reading from dynamometer.
  - 10. Use listed pulling compounds compatible with the cable's outer jacket, the raceway involved, and acceptable to the cable manufacturer. If compatible, use Polywater® Type J or F lubricant.
  - 11. Do not exceed pulling tension of 0.008 pounds per circular mil of conductor cross sectional area.

- 12. Pull cable from end resulting in least amount of tension applied to cable. Pull cables down-grade with the feed-in point at the manhole or building with the highest elevation. Keep pulling tension to a minimum by liberal application of lubricant, hand turning of reel and slack feeding of cable into duct entrance. Employ not less than one person at each reel and one at each manhole during pulling operation. Use 6 personnel minimum when each phase is on a separate reel.
- 13. Remove all lashings used for temporary bunching of individual cables before they enter the raceways.
- 14. Install cable in manholes along those walls providing the longest route and most spare cable lengths. Loop cables around the entire inside diameter of manholes where possible. Arrange cable to avoid interferences with duct entrances into manhole to allow future cable installation without relocation of cables.
- 15. Where required, use pulling eyes and bolts with long barrel ferrules that compress on to the exposed conductors. Follow cable manufacturer's instructions for application of pulling eyes.
- 16. Do not pull cable into conduit embedded in concrete until after concrete is poured and has set up.
- 17. Where cable is pulled under tension over sheaves, conduit bends or other curved surfaces, select radium that will not result in excessive sidewall pressure and include sheaves, conduit bends or other curved surfaces in above calculations.
- S. Splices, Taps and Terminations
  - 1. Approved splices and taps are indicated on Drawings. Obtain preapproval from the Engineer or Owner in writing for any additional required splices and taps.
  - 2. Provide terminals and connectors acceptable for the type of conductor used.
  - 3. Follow the manufacturer's installation instructions for all approved splices, taps and terminations. For DIN plug-in connections, only factory trained and certified installers are to be used.
  - 4. Ground/earth cable shield at each splices, taps and terminations.
  - 5. Use tools specified in this Section, for the required task, instead of a standard utility knife, when cutting the outer jacket, tape-shields, semi-conductor insulation or stripping insulation from medium-voltage cables.
  - 6. Support cable splices and taps on each side of the splice or tap. Locate splices or taps to prevent cyclic bending in the spliced sheath. Splices or taps shall not rely on the cable for support.
  - 7. Provide temporary seal over exposed conductors using tape and heat shrink sleeving unless splicing and taps are to be completed immediately.
  - 8. For grounding cable shield at each termination and splice, use one- or twohole appropriately sized compression connectors on cable shields and join connectors using properly sized corrosion-resistant bolts, lock-washers and nuts. Install washers on the lug side of the connection. Torque bolts to recommended values. Split-bolt type connectors are not approved.
  - 9. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
  - 10. Install separable insulated-connector components as follows:
    - a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
    - b. Portable Feed-Through Accessory: Three.

- c. Standoff Insulator: Three.
- T. Other Installation Requirements
  - 1. Locate approved splices and taps in manholes to enable periodic thermal imaging of the splice or tap to be carried out by Owner.
  - 2. Cable types to be used:
    - a. Single Conductor Medium-Voltage Cable Shielded: Use for above and underground applications (except for Jumper Cable applications see Jumper Cable below) and install in conduit or other raceways. Use in cable trays in dedicated electrical vaults or rooms only.
  - 3. Support cables in manholes and similar locations with cable racks and secure to rack insulators with self-locking nylon cable ties. Place each cable on a separate insulator.
  - 4. For single-conductor mounting, install all phases from the same circuit on the same rack. Do not install cables of more than one circuit on the same insulator.
  - 5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
  - 6. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
  - 7. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
  - 8. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
  - 9. Avoiding Cable Strain: Cable shall be trained to final location and secured with temporary ties prior to any cutting. Terminations installed on the cable shall be oriented to permit completion of the termination without twisting or stressing the cable insulation.
  - 10. Bending and Training Cable: The bend radius of any cable shall not be less than fifteen times the outside diameter of the cable jacket. Cable shall not be twisted.
  - 11. Contractor shall be responsible for the correct phasing out of the conductors of each circuit at terminations and/or splices.
- U. Install cable splices at pull points and elsewhere as indicated; use standard kits.
- V. Arc Proofing: After all tests have been performed and accepted, arc-proof medium voltage cables and termination assemblies within the manhole and at locations not protected by conduit or termination materials except where indicated. Do not fire tape termination assemblies in medium voltage switchgear or transformers. Fire tape each individual phase conductor. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
  - 1. Clean cable sheath.
  - 2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
  - 3. Smooth surface contours with electrical insulation putty.
  - 4. Fireproof cables installed in manholes with one layer of one-half-lapped 3M Scotch® 77 or Plymouth-Bishop 53 tape. Apply vinyl side to outside of wrap. Wrap 3M Scotch 27 or 69 tape over fireproofing tape to hold the half-lapped tape in place and prevent unraveling.
  - 5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

- 6. Fireproof all three-phase cables together ending a minimum of 6 feet (1.83 m) from the splice or connectors, and then individually wrap each phase conductor up to the splice or connector. This works best if the individual wraps are applied first, and then the triplex-cables are wrapped afterward to overlap the tape and adequately protect all cable surfaces.
- 7. Completely cover each individual and triplex cable with fireproofing tape and hand-taped splices from duct entrance to duct exit.
- 8. Extend half-lapped wraps a minimum of 1-inch into all ducts.
- 9. Extend the fireproofing tape a minimum of 1-inch onto all splice and Tconnector bodies.
- W. Termination requirements:
  - 1. Torque values specified by the termination manufacturer must be strictly adhered to.
  - 2. Contractor shall follow the termination manufacturers specified procedures, strictly, in detail.
- X. Site and Work Conditions: The site of the work and working conditions and procedures shall comply with the following:
  - 1. Clean dry work site a clean dry site shall be provided for constructing all terminations. Termination work shall be done only in sunny dry weather, unless a heated and lighted enclosure for the work is provided by the Contractor.
  - 2. Clean drop cloths shall be provided for laying of parts and tools.
  - 3. Hand cleaning supplies packaged cleaning tissues impregnated with an evaporating cleaning compound and clean dry cotton cloths shall be provided for the termination workmen to clean and dry their hands.
  - 4. Adequate lighting natural or artificial lighting provided by the Contractor, shall be used to provide not less than 200 footcandles on the work to be assembled.
  - 5. Manufacturer's instructions work will be permitted at such time as the termination manufacturers installation and assembly instructions are at work site and easily available to the termination workmen.
- Y. Required tool set all tools required for assembly shall be at the work site prior to beginning termination. The set shall include:
  - 1. Cable shears and hacksaw (or rotating blade cable cutter). Roughing cut may be made with shears. Final cable cut shall be made with hacksaw or rotating blade cable cutter.
  - 2. Crimping tool with proper dies for conductors terminated, including grounding cable and ground leads from ground adapters.
  - 3. Torque wrench (and spanner wrench for 600 amp).
  - 4. Rotary blade insulation cutter and sharp knife.
  - 5. Sandpaper and insulation file.

### 3.4 CABLE GROUNDING:

- A. Ground shields of all shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturer's written instructions. Use cable shield adaptor kits, unless noted otherwise.
- B. Connect the primary cable grounding conductors to the ground lug at the transformers and in turn to the ground rod.

- C. The shields of all primary cable terminations shall be bonded to the local ground in each piece of equipment.
- D. Bare #4/0 AWG, copper 1200 volt, equipment ground conductor shall be provided in all medium voltage cable runs.
- E. Ground all cable shields to new #4/0 AWG bare copper ring around interior of each vault. Bond ring to new ground rods and to new #4/0 bare copper conductors in medium voltage conduit runs.
- F. For grounding cable shield at each termination and splice, use one- or two-hole appropriately sized compression connectors on cable shields and join connectors using properly sized corrosion-resistant bolts, lock-washers and nuts. Install washers on the lug side of the connection. Torque bolts to recommended values. Split-bolt type connectors are not approved.

## 3.5 INSTALLATION OF CABLE ACCESSORIES

A. Tape for first course on metal objects in contact with cable, such as racks, shall be 10 mil thick, corrosion protective, moisture resistant PVC pipe wrapping tape.

## 3.6 IDENTIFICATION

- A. Identify cables according to Division 26 Section "Identification for Electrical Systems."
- B. Cables shall be identified in two locations:
  - 1. Identify each cable bundle (related A, B and C phase cables) as to manufacturer's product number (MV-105), year installed, voltage (5 kV), conductor size, and Owner's circuit numbering scheme.
  - 2. Identify each phase cable as to Phase, conductor size, and Owner's circuit numbering scheme.
- C. Identification shall be carried in plastic embossed letter holder permanently secured with black nylon ty-wraps where the cable emerges into each and all manholes or switchgear. Identification shall be applied over the fire tapping where present.
- D. The cables shall be identified with a 2" wide band of Scotch 35 colored insulation tape adjacent to all splices and terminations. The colors shall correspond to the following code.
  - 1. Phase A Two red bands
  - 2. Phase B Two yellow bands
  - 3. Phase C Two blue bands
  - 4. Equipment grounding conductor Green
- E. Provide above mentioned identification on all new cables and all existing cables in each underground vault.

# 3.7 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
  - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Remove and replace malfunctioning items and retest as specified above.

# 3.8 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
  - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

# END OF SECTION

# SECTION 26 05 19

# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Copper building wire.
  - 2. Aluminum building wire.
  - 3. Nonmetallic underground conduit with conductors, Type NUCC.
  - 4. Metal-clad cable, Type MC.
  - 5. Armored cable, Type AC.
  - 6. Photovoltaic cable, Type PV.
  - 7. Mineral-insulated cable, Type MI.
  - 8. Tray cable, Type TC.
  - 9. Fire-alarm wire and cable.
  - 10. Connectors and splices.

## PART 2 - PRODUCTS

- 2.1 COPPER BUILDING WIRE
  - A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
  - B. Manufacturers:
    - 1. Southwire.
    - 2. General Cable.
    - 3. Encore.
    - 4. Or approved equal.
  - C. Standards:
    - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
    - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
  - D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
  - E. Conductor Insulation:
    - 1. Type THHN and Type THWN-2: Comply with UL 83.
    - 2. Type XHHW-2: Comply with UL 44.

### 2.2 ALUMINUM BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn aluminum currentcarrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers:
  - 1. Southwire.

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 2. General Cable.
- 3. Encore.
- 4. Or approved equal.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.
- E. Conductor Insulation:
  - 1. Type THHN and Type THWN-2: Comply with UL 83.
  - 2. Type XHHW-2: Comply with UL 44.
- 2.3 CONNECTORS AND SPLICES
  - A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - B. Manufacturers:
    - 1. Thomas & Betts.
    - 2. Burndy.
    - 3. O-Z/Gedney
    - 4. Or approved equal.
  - C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc diecast with set screws, designed to connect conductors specified in this Section.
  - D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
    - 1. Material: Copper.
    - 2. Termination: Compression.

# PART 3 - EXECUTION

- 3.1 CONDUCTOR MATERIAL APPLICATIONS
  - A. Feeders:
    - 1. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
  - B. Branch Circuits:
    - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
  - A. Feeders and Branch Circuits on Roof, Underground, in Concrete, or Exposed to Sunlight: Type XHHW-2, single conductors in raceway.

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

B. Feeders and Branch Circuits in all other locations: Type THHN/THWN-2, single conductors in raceway.

# 3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

# 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

## 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### 3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according using a UL Listed Firestopping Assembly.
- 3.7 FIELD QUALITY CONTROL
  - A. Tests and Inspections:

- 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
- 2. Perform each of the following visual and electrical tests:
  - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
  - b. Test bolted connections for high resistance using one of the following:
    - 1) A low-resistance ohmmeter.
    - 2) Calibrated torque wrench.
    - 3) Thermographic survey.
  - c. Inspect compression-applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
- 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
  - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

# END OF SECTION

### SECTION 26 05 26

# GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

- 1.1 SUMMARY
  - A. Section includes grounding and bonding systems and equipment.

### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- 1.3 CLOSEOUT SUBMITTALS
  - A. Project Record Documents: Record as-built locations of components and grounding electrodes.

### PART 2 - PRODUCTS

- 2.1 SYSTEM DESCRIPTION
  - A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - B. Comply with UL 467 for grounding and bonding materials and equipment.
- 2.2 CONDUCTORS
  - A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

## 2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Mechanical Connectors:
  - 1. Bronze connectors, suitable for grounding and bonding applications, in configurations required for installation.
- C. Exothermic Connections:
  - 1. Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

# PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- C. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

### 3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnecttype connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

# 3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

- a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
- b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
  - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  - 4. Substations and Pad-Mounted Equipment: 5 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

# END OF SECTION

## SECTION 26 05 29

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### 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. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel non slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel circularly perforated channel systems. Slotted perforated channels are not allowed. Include Product Data for components.
  - 3. Slotted perforated channels are not allowed. Include Product Data for components.

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4. Equipment supports.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- 1.7 QUALITY ASSURANCE
  - A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
  - B. Comply with California Electrical Code.
- 1.8 COORDINATION
  - A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
  - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

# PART 2 - PRODUCTS

# 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to California Electrical Code and OSHPD compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic circularly perforated Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. Allied Tube & Conduit.
- b. Cooper B-Line, Inc.; a division of Cooper Industries.
- c. Fabco Plastics Wholesale Limited.
- d. Seasafe, Inc.
- 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
- 4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used. Testing Per ESR reports and OSHPD requirements.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.;
      - 5) Masterset Fastening Systems Unit.
      - 6)
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.

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- 6) Tomarco (Blue Bangers or Grey Bangers)
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
- 6. Toggle Bolts: All-steel springhead type.
- 7. Hanger Rods: Threaded steel. Slick rods not allowed.
- 8. Where fire insulation is removed or disturbed for the installation of anchors, supports or shot-pins. Repair and reapply insulation to maintain the rating of the area where insulation was disturbed.

### 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

### PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in California Electrical Code. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 <Insert number> percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in California Electrical Code.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified

loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

# END OF SECTION

## **SECTION 26 05 33**

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 11 SUMMARY

- Α. Section Includes:
  - 1. Conduit.
  - 2 Outlet boxes.
  - 3 Pull and junction boxes.

#### B. **Related Requirements:**

Section 26 00 00 "Common Work Results for Electrical Work" for 1 additional abbreviations, definitions, submittals, gualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

### PART 2 - PRODUCTS

- 21 TYPE EMT-S RACEWAYS AND ELBOWS
  - Α. Steel Electrical Metal Tubing (EMT-S) and Elbows:
    - Applicable Standards: 1.
      - Regulatory Requirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
      - General Characteristics: b.
        - Reference Standards: UL 797 and UL Category Control 1) Number FJMX.
        - 2) Material: Steel
        - 3) Exterior Coating: Zinc.
        - Interior Coating: Zinc with organic top coating. 4)
      - Options: C.
        - 1) Minimum Trade Size: 1/2 inch.
        - 2) Colors: As indicated on Drawings.
- TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES 2.2
  - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Α. Couplings, and Nipples:
    - 1. Applicable Standards:
      - Regulatory Requirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
      - b. General Characteristics:
        - Reference Standards: UL 6 and UL Category Control 1) Number DYIX.
        - 2) Exterior Coating: Zinc.
        - 3) Interior Coating: Zinc with organic top coating.
      - Options: c.
        - Minimum Trade Size: 3/4 inch. 1)
        - 2) Colors: As indicated on Drawings.

# 2.3 TYPE FMC-S RACEWAYS

- A. Steel Flexible Metal Conduit (FMC-S):
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standard: UL 1 and UL Category Control Number DXUZ.
      - 2) Material: Steel.
    - c. Options:
      - 1) Minimum Trade Size: 1/2 inch.
      - 2) Colors: As indicated on Drawings.

### 2.4 TYPE LFMC RACEWAYS

- A. Steel Liquidtight Flexible Metal Conduit (LFMC-S):
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standard: UL 360 and UL Category Control Number DXHR.
        - 2) Material: Steel.
    - c. Options:
      - 1) Minimum Trade Size: 1/2 inch.
      - 2) Colors: As indicated on Drawings.

### 2.5 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Fittings for Type ERMC Raceways:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 514B and UL Category Control Number DWTT.
      - 2) Material: Galvanized Steel.
      - 3) Coupling Method: Threaded.
- B. Fittings for Type EMT Raceways:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 514B and UL Category Control Number FKAV.
      - 2) Material: Steel.
      - 3) Coupling Method: Raintight compression coupling with distinctive color gland nut.
- C. Fittings for Type FMC Raceways:
  - 1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
  - 1) Reference Standards: UL 514B and UL Category Control Number ILNR.
- D. Fittings for Type LFMC Raceways:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 514B and UL Category Control Number DXAS.
- 2.6 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT
  - A. Applicable Standards:
    - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and approved by authorities having jurisdiction for application to threaded conduit assemblies.
    - 2. General Characteristics:
      - a. Reference Standards: UL 2419 and UL Category Control Number FOIZ.
- 2.7 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS
  - A. Metallic Outlet Boxes:
    - Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
    - 2. Applicable Standards:
      - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
      - b. General Characteristics:
        - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
      - c. Options:
        - 1) Material: Sheet steel.
  - B. Metallic Conduit Bodies:
    - 1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    - 2. Applicable Standards:
      - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
      - b. General Characteristics:
        - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
  - C. Metallic Device Boxes:

- 1. Description: Box with provisions for mounting wiring device directly to box.
- 2. Applicable Standards:
  - Regulatory Reguirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
  - b. General Characteristics:
    - Reference Standards: UL 514A and UL Category Control 1) Number QCIT.
  - Options: C.
    - 1) Material: Sheet steel.
- D. Metallic Extension Rings:
  - Description: Ring intended to extend sides of outlet box or device box to 1. increase box depth, volume, or both.
  - 2. Applicable Standards:
    - Regulatory Requirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
    - General Characteristics: b.
      - Reference Standards: UL 514A and UL Category Control 1) Number QCIT.

#### 2.8 **TERMINATION BOXES**

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
  - 1. Applicable Standards:
    - Regulatory Requirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 1773 and UL Category Control Number XCKT.
      - 2) Listed and labeled for installation on line side of service equipment.
- C. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
  - Applicable Standards: 1.
    - Regulatory Requirements: Listed and labeled in accordance with a. NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 1773 and UL Category Control Number XCKT.
      - 2) Listed and labeled for installation on load side of service equipment.
- 2.9 CABINETS, CUTOUT BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES
  - Α. Indoor Sheet Metal Cabinets:

- 1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
- 2. Applicable Standards:
  - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - b. General Characteristics:
    - 1) Reference Standards: UL Category Control Number CYIV.
      - a) Non-Environmental Characteristics: UL 50.
      - b) Environmental Characteristics: UL 50E.
  - c. Options:
    - 1) Degree of Protection: Type 1.
- B. Indoor Sheet Metal Junction and Pull Boxes:
  - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
  - 2. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL Category Control Number BGUZ.
        - a) Non-Environmental Characteristics: UL 50.
        - b) Environmental Characteristics: UL 50E.
    - c. Options:
      - 1) Degree of Protection: Type 1.
- C. Indoor Sheet Metal Miscellaneous Enclosures:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards:
        - a) UL 1773 and UL Category Control Number XCKT.
        - b) Non-Environmental Characteristics: UL 50.
        - c) Environmental Characteristics: UL 50E.
    - c. Options:
      - 1) Degree of Protection: Type 1.
- D. Outdoor Sheet Metal Cabinets:
  - 1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
  - 2. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL Category Control Number CYIV.
        - a) Non-Environmental Characteristics: UL 50.
        - b) Environmental Characteristics: UL 50E.
    - c. Options:
      - 1) Degree of Protection: Type 3R.
- E. Outdoor Sheet Metal Junction and Pull Boxes:
  - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

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- 2. Applicable Standards:
  - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - b. General Characteristics:
    - 1) Reference Standards: UL Category Control Number BGUZ.
      - a) Non-Environmental Characteristics: UL 50.
      - b) Environmental Characteristics: UL 50E.
  - c. Options:
    - 1) Degree of Protection: Type 3R.
- F. Outdoor Cast-Metal Junction and Pull Boxes:
  - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
  - 2. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL Category Control Number BGUZ.
        - a) Non-Environmental Characteristics: UL 50.
        - b) Environmental Characteristics: UL 50E.
      - c. Options:
        - 1) Degree of Protection: Type 3R.
- G. Outdoor Sheet Metal Miscellaneous Enclosures:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards:
        - a) UL 1773 and UL Category Control Number XCKT.
        - b) Non-Environmental Characteristics: UL 50.
        - c) Environmental Characteristics: UL 50E.
    - c. Options:
      - 1) Degree of Protection: Type 3R.
- 2.10 COVER PLATES FOR DEVICES BOXES
  - A. Metallic Cover Plates for Device Boxes:
    - 1. Applicable Standards:
      - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
      - b. General Characteristics:
        - 1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
        - 2) Wallplate-Securing Screws: Metal with head color to match wallplate finish.
      - c. Options:
        - Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
        - 2) Wallplate Material: 0.032 inch thick Type 302/304 nonmagnetic stainless steel with brushed finish.
      - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

# 2.11 HOODS FOR OUTLET BOXES

- A. Extra-Duty, While-in-Use Hoods for Outlet Boxes:
  - 1. Applicable Standards:
    - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
    - b. General Characteristics:
      - 1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
      - 2) Marked "Extra-Duty" in accordance with UL 514D.
      - 3) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
      - 4) Mounts to box using fasteners different from wiring device.
    - c. Options:
      - 1) Provides clear, weatherproof, "while-in-use" cover.
      - 2) Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

# PART 3 - EXECUTION

### 3.1 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
  - 1. Exposed Conduit: ERMC.
  - 2. Concealed Conduit, Aboveground: ERMC.
  - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- C. Indoors:
  - 1. Exposed and Subject to Physical Damage: ERMC.
  - 2. Exposed, Not Subject to Physical Damage: EMT.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 4. Damp or Wet Locations: ERMC.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC.
- D. Stub-ups to Above Recessed Ceilings: Provide EMT or ERMC for raceways.
- E. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
  - 1. ERMC: Provide threaded type fittings unless otherwise indicated.

## 3.2 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

- B. Degree of Protection:
  - 1. Outdoors:
    - a. Type 3R unless otherwise indicated.
    - b. Locations Exposed to Hosedown: Type 4.
    - c. Locations Subject to Potential Flooding: Type 6P.
    - d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
    - e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.
    - f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.
  - 2. Indoors:
    - a. Type 1 unless otherwise indicated.
    - b. Damp or Dusty Locations: Type 12.
    - c. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: Type 4.
    - d. Locations Exposed to Hosedown: Type 4.
    - e. Locations Exposed to Brief Submersion: Type 6.
    - f. Locations Exposed to Prolonged Submersion: Type 6P.
    - g. Locations Exposed to Corrosive Agents: Type 4X.
- C. Exposed Boxes Installed Less Than 6.5 ft. Above Floor:
  - 1. Provide cast-metal boxes. Boxes with knockouts or unprotected openings are prohibited.
  - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

### 3.3 INSTALLATION OF RACEWAYS

- A. Installation Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
  - 2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
  - 3. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
  - 4. Comply with NECA NEIS 101 for installation of steel raceways.
  - 5. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
  - 6. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch trade size and insulated throat metal bushings on 1-1/2 inch trade size and larger conduits terminated with locknuts..
  - 7. Raceway Terminations at Locations Subject to Moisture or Vibration:
    - a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG..
- B. General Requirements for Installation of Raceways:
  - 1. Complete raceway installation before starting conductor installation.
  - 2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft. above finished floor.

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- 3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
- 4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
- 5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- 6. Support conduit within 12 inch of enclosures to which attached.
- 7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
- 8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
  - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - b. Where an underground service raceway enters a building or structure.
  - c. Conduit extending from interior to exterior of building.
  - d. Conduit extending into pressurized duct and equipment.
  - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - f. Where otherwise required by NFPA 70.
- 9. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
- 10. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- 11. Cut conduit perpendicular to the length. For conduits 2 inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
- 12. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- C. Requirements for Installation of Specific Raceway Types:
  - 1. Types ERMC:
    - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
  - 2. Types FMC and LFMC:
    - a. Comply with NEMA RV 3. Provide a maximum of 72 inch of flexible conduit forequipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- D. Stub-ups to Above Recessed Ceilings:
  - 1. Provide EMT or ERMC for raceways.
  - 2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- E. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
  - 1. EMT: Provide setscrew, fittings. Comply with NEMA FB 2.10.
  - 2. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
- F. Raceways Penetrating Rooms or Walls with Acoustical Requirements:
  - 1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

### 3.4 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- C. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- D. Locate boxes so that cover or plate will not span different building finishes.
- E. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- F. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
- G. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- H. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- I. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
  - 1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
  - 2. Provide gaskets for wallplates and covers.
- 3.5 FIRESTOPPING
  - A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

## 3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

# 3.7 CLEANING

A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

# END OF SECTION

# SECTION 26 05 43

### UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. This Section includes the following:

- 1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs.
- 2. Handholes and boxes.
- 3. Manholes.

### 1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

### 1.4 ACTION SUBMITTALS

- A. All documentation associated with this contract including submittals, shop drawings, O&M manuals, and test reports shall be furnished as follows.
  - 1. Documents shall be submitted in a portable document format (.pdf) with high resolution images, properly rotated, with annotations indicating the exact product being proposed with the applicable options and accessories. The file shall be tabbed and include a table of contents.
- B. Product Data: For the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Accessories for manholes, handholes, boxes, and other utility structures.
  - 4. Warning tape.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Duct entry provisions, including locations and duct sizes.
  - 3. Reinforcement details.
  - 4. Frame and cover design and manhole frame support rings.
  - 5. Ladder details.
  - 6. Grounding details.
  - 7. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps. \
  - 8. Joint details. Cover design.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  - 2. Drawings shall be signed and sealed by a qualified professional engineer.
  - 3. Submit warranted concrete thermal backfill mix to document the thermal resistivity (RHO) as noted herein.
- B. Qualification Data: For professional engineer and testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- 1.6 QUALITY ASSURANCE
  - A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
  - B. Comply with ANSI C2.
  - C. Comply with NFPA 70.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

### 1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

# PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

# 2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ARNCO Corp.
  - 2. CertainTeed Corp.; Pipe & Plastics Group.
  - 3. Condux International, Inc.
  - 4. ElecSys, Inc.
  - 5. Electri-Flex Company.
  - 6. IPEX Inc.
  - 7. Lamson & Sessions; Carlon Electrical Products.
  - 8. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
  - 1. Duct Separators: Factory-fabricated rigid PVC 3/8" thick High-Density Polyethylene spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings of 48" while supporting ducts during concreting or backfilling.
  - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
- C. Duct Sealant Compound:
  - 1. Manufacturer: GB Gardner Bender, model DS-130 or equal.
  - 2. Seals conduit openings against drafts, dust, moisture and noise.
  - 3. Protects switchgear, electrical equipment, terminal boxes and interior spaces from corrosive elements.
  - 4. Will not harden or form a skin under normal conditions.
  - 5. Not for use outdoors.
  - 6. Specifications:
    - a. Viscosity: ASTM D-217 300-gram load 7.0 -11.0; ASTM DS-S2 100gram load - 9.0 -15.0
    - b. Temperature Range: Adheres at -20 °F (-29 °C). Will not slump after 1 hr. at 350 °F (175 °C).
    - c. Flash Point: Over 550 °F (285 °C).
    - d. Other Properties: Non-conducting, non-deteriorating, non-toxic, non-corrosive, non-staining, non-curable; 99% solid, coil-based.
- D. Expandable Duct Plugs:
  - 1. Manufacturer: Innerduct.com, model JM-BLA-50D535U or equal.
  - 2. Blank duct plugs effectively seal conduits to reduce the cost of cable placement and maintenance in new underground construction projects and routine work. These plugs prevent the flow of water and the costly sedimentation of duct banks and conduit systems while confining problems of dangerous vapors to their source.
  - 3. Expandable Duct Plugs Shall have the following characteristics:
    - a. High-impact plastic components, combined with durable elastic gaskets.
    - b. Corrosion proof and effective as long-term or temporary seal.
    - c. Shall be water-tight and gas-tight.
    - d. Equipped with a rope tie device to allow the securing of pull rope to the plug's back compression plate.
    - e. Shall be removable and reusable.

## 2.3 PRECAST MANHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Christy Concrete Products.
  - 2. Oldcastle Precast Group.
  - 3. Riverton Concrete Products; a division of Cretex Companies, Inc.
  - 4. Utility Concrete Products, LLC.
  - 5. Utility Vault Co.
  - 6. Wausau Tile, Inc.
- B. Comply with ASTM C 858, with structural design loading as required for location of manhole and with interlocking mating sections, complete with accessories, hardware, and features.
  - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
    - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
    - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
  - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    - a. Type and size shall match fittings to duct or conduit to be terminated.
    - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
  - 3. Covers: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - b. Cover Legend: Molded lettering, "ELECTRIC" or "TELECOM" as required for use.
  - 4. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- C. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
  - 1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
  - 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
  - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-(50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
  - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-(32-mm-) diameter eye, rated **2500-lbf (11-kN)** minimum tension.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

# 2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
  - 1. Color: Gray.
  - 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
  - 3. Cover: Weatherproof having structural load rating consistent with enclosure. Provide tamper-resistant locking devices where located outside the secure property fence line.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC."
  - 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation.
    - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheetmolded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. Christy Concrete Products.
    - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

### 2.5 PRECAST MANHOLES

A. Available Manufacturers: Subject to compliance with the local utility provider service area requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1. Oldcastle Precast Group.
- 2. Stay-Right
- 3. Utility Precast
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
  - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
    - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
  - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    - a. Type and size shall match fittings to duct or conduit to be terminated.
    - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

# 2.6 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Bilco Company (The).
  - 2. Campbell Foundry Company.
  - 3. Carder Concrete Products.
  - 4. Christy Concrete Products.
  - 5. East Jordan Iron Works, Inc.
  - 6. Elmhurst-Chicago Stone Co.
  - 7. McKinley Iron Works, Inc.
  - 8. Neenah Foundry Company.
  - 9. NewBasis.
  - 10. Oldcastle Precast Group.
  - 11. Osburn Associates, Inc.
  - 12. Pennsylvania Insert Corporation.
  - 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
  - 14. Strongwell Corporation; Lenoir City Division.
  - 15. Underground Devices, Inc.
  - 16. Utility Concrete Products, LLC.
  - 17. Utility Vault Co.

- 18. Wausau Tile, Inc.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
  - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 36" diameter round cover with a 30" minimum ingress/egress opening.
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
  - 2. Cover Legend: Cast in. Selected to suit system.
    - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
    - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
  - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
    - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
  - 4. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron. A four inch deep by 15 inch diameter sump hole with removable cover shall be included in the bottom of the manhole to allow for water removal. The sump hole shall be located directly underneath the access hole in the center of the manhole.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inchdiameter eye, and 1-by-4-inch bolt.
  - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inchdiameter eye, rated 2500-lbf minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
  - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2inchID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
  - 1. Tested Ultimate Pullout Strength: 12,000-lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steelwedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- H. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.
  - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1/2-inch centers for cable-arm attachment.

- 2. 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
- 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
  - 1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
  - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperature of 300 deg. F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- K. Fixed Manhole Ladders: Arranged for attachment to roof or wall of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- L. Cover Hooks: Heavy duty, designed for lifts 60-lbf and greater. Two required.
- 2.7 SOURCE QUALITY CONTROL
  - A. Test and inspect precast concrete utility structures according to ASTM C 1037.
  - B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
    - 1. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

### PART 3 - EXECUTION

- 3.1 UNDERGROUND DUCT APPLICATION APPLIES TO EXTERIOR DUCTS AS WELL AS THOSE INSTALLED UNDER BUILDING FLOOR SLABS
  - A. Ducts for Electrical Cables over 600 V: RNC, in concrete-encased duct bank, unless otherwise indicated.
  - B. Ducts for Electrical Feeders 600 V and Less: RNC, in concrete-encased duct bank, unless otherwise indicated.
  - C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated. Conduits shall be concrete-encased under paved roadways and parking areas. Encasement shall extend 10 feet beyond edge of such surfaces.

- D. Underground Ducts for Control, Communications, or Data Circuits: RNC, in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts Crossing Roadways: RNC, encased in steel reinforced concrete.
- 3.2 UNDERGROUND ENCLOSURE APPLICATION EXTERIOR LOCATIONS ONLY
  - A. Handholes and Boxes for 600 V and Less:
    - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
    - Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15, Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15, or Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
  - B. Manholes: Precast concrete.
    - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
    - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.
- 3.3 EARTHWORK
  - A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
  - B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated.
  - C. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."
- 3.4 DUCT INSTALLATION
  - A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
  - B. Curves and Bends: Use manufactured long sweep bends with a minimum radius of 36 inches, both horizontally and vertically, at other locations, unless otherwise indicated. 24" radius bends are only allowed between the two CS switchboard tie sections. Unless otherwise noted, sweeps shall be made using Type EPC-40-PVC conduit. To reduce friction, the Contractor may, propose the use of heavy-wall fiberglass sweeps. Proposal shall be submitted to the Construction Manager (CM) and shall include product data for the specific fiberglass products to be used and any resulting price adjustment. The Contractor shall not proceed with use of fiberglass sweeps without prior approval by the CM. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
  - C. Duct Entrances to Manholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
    - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

- 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- D. Sealing:
  - 1. Provide temporary closure at terminations of ducts when installed.
  - 2. All underground ducts that are run below the vapor barrier and that enter the building shall be sealed with duct sealant compound. Seals shall be made indoors where conduits enter switchgear, control panels, other enclosures and/or directly into rooms. Seals shall be made after the installation of wire and cables. Seals shall be a minimum of 4" deep and shall be made so that any vapors present in the conduits shall not seep into the interior spaces.
  - 3. Seal spare ducts at interior terminations with expandable duct plugs. Plugs shall prevent the flow of water and dangerous vapors to the interior of electrical equipment and interior spaces.
  - 4. Duct sealing compound and expandable plug shall withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- E. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares. For all spare conduits, provide a label indicating the source of the pull cord.
- F. Concrete-Encased Ducts: Support ducts on duct separators.
  - Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
    - c. The conduits should be secured in position to prevent them from floating to the top when concrete is placed into the trench.
  - 3. Concrete Mix: 3000-psi, thermal backfill type with a guaranteed maximum thermal resistivity (RHO) of 60 deg. C-cm/W @ 6% moisture content.
  - 4. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
  - 5. Reinforcement: Reinforce concrete-encased duct banks where they pass under roadways. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

- 6. Forms: Use walls of trench to form side walls of duct bank where soil is selfsupporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- 7. Minimum Space between Ducts: 4 inches (100 mm) between ducts and exterior envelope wall. Minimum spacing between power conduits shall be determined by duct bank heat load calculations. Submit calculations to Engineer for approval.
- 8. Depth: Install top of duct bank for medium voltage conduits at least 48 inches (1,200 mm) below finished grade. It may be installed a minimum of 24 inches below finished grade where necessary to meet heat calculation test provided it meets local, state and national code requirements.
- 9. Install top of duct bank for 600V and below at least 24 inches (600 mm) in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
- 10. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow. Provide PVC bell end fittings for all conduits that terminate under floor mounted equipment.
- 11. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.
- 12. A #4/0 bare copper ground wire shall be installed in the concrete of the duct bank installation following the instructions below. A ten-foot tail of the #4/0 copper must be left exposed inside of each vault, manhole or other tie-in location with the entry location grouted and sealed.
  - a. Install the bottom spacers and the bottom row of PVC conduits in the trench.
  - b. Install the #4/0 copper ground wire alternating the wire from position "A" to position "B" in the conduit spacers. The #4/0 copper ground wire is to be sagged with a two-inch minimum clearance from the bottom of the trench.
  - c. If the copper ground wire needs to be spliced in the duct bank between manholes, an exothermic weld shall be used.
  - d. #4 copper ground wire shall terminate at the pad mounted MV switch and transformer bus bar. Refer to drawings for additional information.
- 3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES EXTERIOR LOCATIONS ONLY
  - A. Cast-in-Place Manhole Installation:
    - 1. Finish interior surfaces with a smooth-troweled finish.
    - 2. Windows for future duct connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
    - 3. Cast-in-Place concrete, formwork, and reinforcement are specified in division 03 section "cast-in-place concrete."
  - B. Precast concrete handhole and manhole installation:
    - 1. Comply with ASTM C 891, unless otherwise indicated.

- 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
- 3. Unless otherwise indicated, support units on a level bed of 6" crushed stone or gravel, graded from 1-inch sieve to no. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
  - 1. Manhole roof: install with rooftop at least 15 inches below finished grade.
  - 2. Manhole frame: in paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
  - 3. Install handholes with bottom below the frost line.
  - 4. Handhole covers: in paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
  - 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Manhole access: circular opening in manhole roof; sized to match cover size.
  - 1. Manholes with fixed ladders: offset access opening from manhole centerlines to align with ladder.
  - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Hardware: install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- F. Fixed manhole ladders: arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- G. Field-installed bolting anchors in manholes and concrete handholes: do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- 3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE EXTERIOR LOCATIONS ONLY
  - A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
  - B. Unless otherwise indicated, support units on a level bed of 6" crushed stone or gravel, graded from 1/2-inch sieve to no. 4 sieve and compacted to same density as adjacent undisturbed earth.
  - C. Elevation: in paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
  - D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- 3.7 GROUNDING
  - A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

# 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  - 2. Pull aluminum, polymer or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

# 3.9 CLEANING

- A. Pull leather-washer-type or cloth duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber or cloth duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

### SECTION 26 05 48.16

#### SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

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. Restraint channel bracings.
  - 2. Restraint cables.
  - 3. Seismic-restraint accessories.
  - 4. Mechanical anchor bolts.
  - 5. Adhesive anchor bolts.
- B. Related Requirements:
  - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by OSHPD.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
  - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.
    - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - 3. Seismic Restraint Details:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the

structure during seismic events. Indicate association with vibration isolation devices.

- c. Retain first subparagraph below if Project includes equipment mounted outdoors.
- d. Coordinate seismic-restraint and vibration isolation details with windrestraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- e. Preapproval and Evaluation Documentation: By OSHPD showing maximum ratings of restraint items and the basis for approval (tests or calculations).

# 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints. Electrical components include:
  - 1. Control panels.
  - 2. Generators.
  - 3. Luminaires.
  - 4. Panelboards.
  - 5. Substations.
  - 6. Switchboards.
  - 7. Switchgear.
  - 8. Transformers.
  - 9. Unit substations.
- B. Qualification Data: testing agency
- C. Welding certificates.
- D. Field quality-control reports.

# 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD (HCAI) in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with California Electrical Code.

### PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: D.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
    - a. Component Importance Factor: 1.5
    - b. Component Response Modification Factor: 1.5
    - c. Component Amplification Factor: 1.0
  - 3. Design Spectral Response Acceleration at Short Periods (Per S001=0.563g):
  - 4. Design Spectral Response Acceleration at 0.351g (per S001)

#### 2.2 RESTRAINT CHANNEL BRACINGS

A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

#### 2.3 RESTRAINT CABLES

A. Restraint Cables: ASTM A603 galvanized steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

### 2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and waterresistant neoprene, with a flat washer face.

#### 2.5 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinccoated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.
- 2.6 ADHESIVE ANCHOR BOLTS
  - A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior

applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.
- B. Equipment and Hanger Restraints:
  - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint devices using methods approved by OSHPD providing required submittals for component.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items

SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

- 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
- 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- 5. Set anchors to manufacturer's recommended torque using a torque wrench.
- 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

# 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Coordinate this article with Drawings.
  - 1. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

# 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

# 3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

# SECTION 26 05 53

# IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### 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. Labels
  - 2. Band and tubes
  - 3. Tapes and stencils
  - 4. Miscellaneous identification products

# 1.3 SUBMITTALS

- A. Product Data: For each type of product
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Delegated-Design Submittal: For arc-flash hazard study

#### PART 2 - PRODUCTS

- 2.1 PERFORMANCE REQUIREMENTS
  - A. Comply with ASME A13.1
  - B. Comply with NFPA 70
  - C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145
  - D. Comply with ANSI Z535.4 for safety signs and labels
  - E. Comply with NFPA 70E requirements for arc-flash warning labels
  - F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969
  - G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes

#### 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.

- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: gray.
  - 6. Color for Equipment Grounds: Green with a yellow stripe.
  - 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Workspace Clearance Warning: "WARNING OSHA REGULATION -AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- E. Equipment Identification Labels:
  - 1. Black letters on a white field for normal power system.
  - 2. White letters on a red field for essential power system.

#### 2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible label with acrylic pressure-sensitive adhesive.
  - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; selflaminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 1. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. 3-1/2 by 5 inches for equipment.

c. As required by authorities having jurisdiction.

# 2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machineprinted identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

# 2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
- D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

# 2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainlesssteel machine screws with nuts and flat and lock washers.

# PART 3 - EXECUTION

# 3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

# 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.

- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- J. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
  - 4. "FIRE ALARM".
- K. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- L. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- O. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

- Q. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

# SECTION 26 05 72

#### SHORT CIRCUIT AND COORDINATION REPORT

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. GENERAL:
  - 1. This section specifies that the Contractor will adjust, set and test all adjustable short circuit and overcurrent protective devices. The Contractor will provide the owner with a short circuit and coordination report which will contain the settings for the protective devices.
- B. SCOPE:
  - 1. The following equipment and associated devices will be included in the scope of the short circuit and coordination study:
    - a. 12.47 kV normal power switchgear.
    - b. 4.16 kV emergency power switchgear.
    - c. 12.47 4.16 kV transformers.
    - d. 4.16 kV 480 V transformers.
    - e. 4.16 kV switchgear.
    - f. 480-volt switchgear and switchboards.
    - g. 480-volt motor control centers.
    - h. 480-volt transfer switches.
    - i. All 12.47 kV cables.
    - j. All 4.16 kV cables.
    - k. All 480-volt feeder cables.
    - I. All 480-volt motors together with motor starters.

#### PART 2 - DELETED

#### PART 3 - EXECUTION

#### 3.1 GENERAL

A. The Contractor shall adjust and set all protective devices associated with the equipment specified in paragraph 1.1. Settings will be provided to the Contractor by the Owner.

#### 3.2 TESTING

A. Protective devices shall be tested in accordance with Division 26.

# SECTION 26 05 74

# ARC-FLASH LABELS

#### PART 1 - GENERAL

# 1.1 DESCRIPTION

- A. GENERAL:
  - 1. This section specifies that the Contractor will provide arc-flash labels for new electrical equipment included in the project scope. Contractor shall submit the arc-flash labels message/content to the owner for review and acceptance.
- B. SCOPE:
  - 1. The following equipment and associated devices will be included:
    - a. Medium voltage metered switchgear and distribution
    - b. 480 volt and 208-volt switchgear, switchboards, panelboards, motor control centers, and load centers.
- PART 2 NOT USED
- PART 3 EXECUTION
- 3.1 GENERAL
  - A. Arc-flash labels shall be provided according to NFPA 70E and section 26 05 53, Electrical Identification, of these specifications.

# SECTION 26 08 50

#### ELECTRICAL ACCEPTANCE TESTING

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes requirements for acceptance testing by an independent testing agency.
- B. Related Documents: The provisions and intent of the Contract, the General and Supplementary Conditions, and Division 1 Specification Sections, apply to the Work as if specified in this Section.
- C. Related Sections:
  - 1. Section 260526 "Grounding and Bonding for Electrical Systems".
  - 2. Section 260923 "Lighting Control Devices".
  - 3. Section 262413 "Switchboards".
  - 4. Section 262416 "Panelboards".
  - 5. Section 263213 "Engine Generators".
  - 6. Section 263600 "Transfer Switches".

#### 1.2 APPLICABLE PUBLICATIONS

- A. All inspections and tests shall be in accordance with the following applicable standards and codes. These publications form a part of this specification to the extent referenced.
  - 1. American Society for Testing and Materials (ASTM):
    - a. D877 Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
  - 2. Insulated Cable Engineers Association (ICEA):
    - a. S-68-516 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
    - b. S-93-63 5-46KV Shielded Power Ethylene-Propylene-Rubber Insulated Wire and Cable for use in the Transmission and Distribution of Electrical Energy.
  - 3. National Electrical Manufacturers Association (NEMA):
    - a. WC8 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. (ICEA S-68-516).
  - 4. Institute of Electrical and Electronic Engineers (IEEE):
    - a. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth surface Potentials of a Ground System.
    - b. 400 Guide for Making High-direct-Voltage Tests on Power Cable Systems in the Field.
  - 5. National Electrical Code NEC.
  - 6. American National Standards Institute ANSI.
  - 7. National Fire Protection Association NFPA.
  - 8. Occupational Safety and Health OSHA 29CFR Part 1910.269.
  - 9. International Electrical Testing Association NETA.
  - 10. State and Local Codes and Ordinances.
  - 11. National Electrical Safety Code (NESC).

# 1.3 TESTING FIRM QUALITY ASSURANCE

- A. Except where otherwise specified for certain power equipment the Testing Firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems being evaluated, and regularly engages in the testing of electrical equipment, devices, installations and systems. The Testing Firm shall have been in business for a minimum of 10 years and meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA) or approved equal:
  - 1. Acceptable Testing Firms:
    - a. Electro-Test (ETI).
    - b. Apparatus Service and Engineering Technology (ASET).
    - c. Siemens/Westinghouse.
    - d. Cutler-Hammer Engineering Services and Systems (formerly Cutler-Hammer Engineering Services and Systems; CHESS).
- B. Testing Firm's Field Supervisor Qualifications: A person, regularly employed by the firm for testing services and currently certified by the International Electrical Testing Association to supervise on-site testing specified.
- C. Submit proof of the above qualifications with bid documents.

# 1.4 GENERAL REQUIREMENTS AND SUBMITTALS

- A. General Scope: Engage the services of a recognized independent testing firm for the purpose of performing quality control inspections and test as herein specified.
  - 1. The Testing Firm shall provide all materials, equipment, labor and technical supervision to perform all tests and inspections to determine suitability of equipment for energization and continued reliable operation.
  - 2. The purpose of these tests is to assure that all tested electrical equipment, both Contractor- and Owner-supplied, is operational within industry and manufacturer's tolerances and that equipment is installed and functioning in the system in accordance with design specifications of the Engineer.
  - 3. The Testing Firm (not the Contractor) shall inspect and test the following equipment:
    - a. Section 260526 "Grounding and Bonding for Electrical Systems".
    - b. Section 262413 "Switchboards".
    - c. Section 262416 "Panelboards".
    - d. Section 263213 "Engine Generators".
- B. Submittals by the Testing Firm:
  - 1. Field Test Reports: Maintain a written record of all tests. Assemble and certify a final test report upon completion of the project, showing dates, personnel making tests, equipment used, equipment or material tested, test performed and results. The field test forms included in the report shall be the original hand-written test results that were recorded and signed by the individual(s) who performed the testing.
- 1.5 DIVISION OF RESPONSIBILITY
  - A. The Contractor shall perform routine insulation-resistance, continuity, and rotation test for all distribution and utilization equipment prior to, and in addition to tests performed by the Independent Testing Firm.

- B. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Firm shall determine the specific power requirements.
- C. The Contractor shall notify the Testing Firm when equipment becomes available for acceptance tests. Coordinate work to expedite project scheduling.
- D. The Contractor shall supply a short-circuit and protective device coordination study, a protective device setting form, a complete set of electrical drawings and specifications, and any pertinent change orders to the Testing Firm prior to commencement of testing.
- E. The Testing Firm shall notify the Contractor and Architect prior to commencement of any testing.

# 1.6 SAFETY

- A. Adhere to safety procedures as required by the following:
  - 1. Occupational Safety and Health Act.
  - 2. Accident Prevention Manual for Industrial Operations, National Safety Council.
  - 3. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
  - 4. American Nat5ional Standards for Personnel Protection: Lockout/Tagout.
  - 5. Applicable state and local safety operating procedures.
- B. Perform all tests with apparatus de-energized, except where specifically required.
- C. Designate a Project Safety Representative to supervise operations with respect to safety.

# PART 2 - PRODUCTS

# 2.1 TEST EQUIPMENT

- A. Utilize test equipment in good mechanical and electrical condition with shape and frequency output waveforms appropriate for the test and the tested equipment:
  - 1. Accuracy shall be appropriate for the test being performed, but not in excess of 2% of the scale being used.
- B. Field test meters used to check installed power system instrument calibration must have an accuracy higher than that of the instrument being checked.

# 2.2 TEST INSTRUMENTS AND CALIBRATION

- A. The Testing Firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy as dictated by the National Institute of Standards and Technology (NIST):
  - 1. Instruments calibration schedule:
    - a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum.
    - b. Laboratory instruments 12 months.
    - c. Leased specialty equipment 12 months (where lessor guarantees accuracy).
  - 2. Provide visible dated calibration labels on all test equipment.
  - 3. Maintain up-to-date instrument calibration instructions and procedures for each test instruments.

- B. Provide all testing equipment required including, but not limited to, the following:
  - 1. Wet and dry-bulb thermometer.
  - 2. 500V, 1000V, 5kV and 15kV meggers.
  - 3. Battery-powered portable telephone sets.
  - 4. DC high-potential adjustable test set for EPR medium-voltage cables.
  - 5. Multimeter (Volts-Ohms-Millimeter) rated 20k ohms per volt or higher.
  - 6. Three-phase rotation meter, 60-Hz.
  - 7. Commercial model three-point earth ground test set that reads directly in ohms.
  - 8. Miscellaneous cable, tst leads, jumpers, test lights, buzzers, bells, switches, plugs, receptacles, and other test equipment as required.
  - 9. Insulation Tester (Megger): 2,000 Megohms for 600V and below. Use appropriate rated megger for tests on MV systems prior to Hi-Pot.
  - 10. Dranetz, BMI Model 355, Fluke 41 or equivalent recording type harmonic analyzer to display individual and total harmonic currents and voltages.
  - 11. Clamp-on Ammeter.
  - 12. Circuit Breaker Current Injections Test Set.

### 2.3 TEST REPORT

- A. Include the following:
  - 1. Summary of Project.
  - 2. Description of equipment tested.
  - 3. Description of test.
  - 4. Test results.
  - 5. Analysis and recommendations.
  - 6. Appendix, including appropriate test forms.
  - 7. List of test equipment used and calibration date.
- B. Furnish 5 copies of the completed report to the Architect no later than thirty days after completion of the project.

#### PART 3 - EXECUTION

#### 3.1 TESTING

- A. General requirements: Test all wire, cable, and electrical equipment installed and connected by the Contractor to assure proper installation, setting, connection, and function as indicated or to conform to Contract Documents and Manufacturer's instructions.
- B. After the installation has been completed, the contractor shall conduct an operating test demonstrating that all equipment and devices operate in accordance with the requirements of the plans and specifications.
  - 1. Perform tests recommended by the equipment manufacturer.
  - 2. Verify phase sequence and rotation for all connections.
  - 3. Be responsible for all damage to equipment or material due to improper test procedures or test apparatus handling.
- C. Infrared Scanning: Perform an infrared scan of transformers two weeks after Substantial Completion and before final acceptance. Make bus joints and connections accessible to a portable scanner and perform scanning during a period of normal working load:

- 1. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for scanning device used for electrical distribution equipment.
- 2. Record of Infrared Scanning: Prepare a certified report identifying all connections checked and describing results of scanning. Document deficiencies detected, remedial action taken, and observations after remedial action.
- D. Emergency Systems:
  - Field/Design Evaluation and Report: Perform a field/design evaluation for emergency diesel generator and associated automatic transfer switch and emergency distribution per published NETA acceptance standards:
    - a. Test Labeling: Upon satisfactory completion of testing for each transformer, attach a dated and signed "Satisfactory Test" label to each tested component.
    - b. Submit above reference field/design evaluation test report to the architect and engineer.
  - 2. Infrared Scanning: Perform an infrared scan of the emergency distribution two weeks after Substantial Completion and before final acceptance. Make bus joints and connections accessible to a portable scanner and perform.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - b. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Low-voltage Switchboards:
  - 1. Testing: After Installing switchboards and after electrical circuitry has been energized, demonstrate produce capability and compliance with requirements:
    - a. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS. Certify compliance with test parameters.
      - 1) Switchgear: Perform inspections and tests stated in NETA ATS, Section 7.1.
      - 2) Circuit Breakers: Perform inspections and tests stated in NETA ATS, Section 7.6
      - 3) Instrument Transformers: Perform inspections and tests stated in NETA ATS;, Section 7.10.
      - 4) Metering and Instrumentation: Perform inspections and tests stated in NETA ATS, Section 7.11.
      - 5) Ground-Fault Systems: Perform inspection sand tests stated in NETA ATS, Section 7.14.
      - 6) Surge Arresters: Perform inspections and tests stated in NETA ATS, Section 7.19.
    - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - c. Verify proper phase rotation of main bus.
    - d. Verify integrity of all ground connections.
  - 2. Interlocks: Verify proper operation of all electrical, mechanical and key interlocks.
  - 3. Infrared Scanning: Perform and infrared scan of switchgear two weeks after Substantial Completion and before final acceptance. Make bus joints and

connections accessible to a portable scanner and perform scanning during a period of normal working:

- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- b. Record of Infrared Scanning: Prepare a certified report that identified switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Grounding:
  - 1. Field/Design Evaluation and Report: Perform a field/design evaluation for grounding systems per published NETA acceptance standard:
    - a. Test Labeling: Upon satisfactory completion of testing for each transformer, attach a dated and signed "Satisfactory Test" label to each tested component.
    - b. Submit above referenced field/design evaluation test report to the architect and engineer.
- G. Control Scheme Tests: Test all electrical controls via trial operation of control equipment after all wiring is completed. Check to see that each interlock and control function operates to conform to the sequence of operation, as indicated in the schematic diagrams and the manufacturer's operating instructions.

### 3.2 COMMISSIONING

A. Coordinate installation and final testing with the Commissioning Agent in accordance with Section 01 9100.

### 3.3 IDENTIFICATION

A. Upon completion of the tests and inspections noted in these specifications, attach a label to all serviced devices indicating the date serviced and the testing company responsible.

# SECTION 26 09 16

#### MV GENERATOR PARALLELING SWITCHGEAR

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section includes all labor, materials, equipment, controllers, devices, network interfaces, cabling and raceways to Owner's LAN network, gateways, software licenses, application software and services necessary for and incidental to design, furnishing, factory testing, factory testing with MV switchgear, delivery, unloading, installation, field testing, integration of equipment supplied by others, training and documentation of newly manufactured Medium Voltage Generator paralleling Switchgear (MVGPS), supporting the design, interface and integration of systems provided by other Suppliers, including, but not limited to Medium Voltage Switchgear and Medium Voltage Diesel-Engine-Driven Generator Sets and the local power utility. The MVGPS shall be designed, manufactured and tested in strict accordance with these Specifications and associated appendices and drawings.
- B. Basis of Design is ASCO Power Technologies.
- C. The requirements of this specification section pertain to MV switchgear lineups MVDSA/MVDSB, MVMGPS, and MVMS2. These three switchgear lineups shall be provided by a single manufacturer and shall function as an integrated system for control of Generator and Utility sources, including provision for closed transition transfer of the loads served between Generator power and Utility power in compliance with ANSI 1547 and the requirements of Pacific Gas and Electric (PG&E).
- D. MVMGPS2 Gen-Control switchgear, MVDSA/MVDSB distribution switchgear, and MVMS2 Main Service Gear shall all comply with the requirements of specification section 26 13 13 (Medium Voltage Circuit Breaker Switchgear.)
- E. The Supplier shall not be required to provide the following:
  - 1. Buildings, foundations, or mounting framework
  - 2. Labor and rigging for unloading and erection.
  - 3. Electrical energy and/or fuel for site testing.

Responsibility	MVGPS Supplier	Generator	General	Cx Agent
Coordination	Provide	Provide	Provide	Provide
MVGPS	Provide	n/a	Provide and Manage	Oversee
Integration of MV Switchgear, Generators and LV inhibits	Provide	Coordinate interfaces, supply information and support integration into MVGPS	Provide and Manage	Oversee
Integration into Remote Monitoring	Provide	Support	Provide and Manage	Oversee
DC Battery	Provide &	Support	Provide and	n/a

# F. Scope demarcation, interfaces and liaisons are listed in following table.

Responsibility	MVGPS Supplier	Generator	General Contractor	Cx Agent
System and AC Supply	document load used to support battery and feeder sizing		Manage	
MVGPS Installation and Connections	Design and Support	Support	Provide	n/a
Level 1a Commissioning: Factory Acceptance Test at MVGPS Supplier facility.	Provide	Supply test units of intelligent devices, support test of interfaces	Provide and Manage	Witness
Level 1b Commissioning: Integrated Factory Acceptance Test (Switchgear Supplier Factory)	Supply Equipment to Switchgear Facility and Provide Controls portion of the test. Include all travel and lodging/ meals cost for (3) people	n/a	Provide and Manage	Witness
Level 2 Commissioning: Field Installation Verification and Construction Tests	Support	n/a	Provide and Manage	Observe and Review Reports
Level 3 Commissioning: Equipment Startup	Provide	Support	Provide and Manage	Support and Review Reports
Level 4 Commissioning: Functional System Testing	Support	Support	Support	Provide
Level 5 Commissioning: Integrated System Testing	Support	Support	Support	Provide
Pull the Plug Test	Support	Support	Provide	Provide
As built drawings, Operations and Maintenance Manuals	Provide	N/A	Provide and Manage	Oversee
Staff Training	Provide	N/A	Provide and Manage	Oversee

# 1.2 REFERENCES

- A. Manufacturer shall comply with the Standards, Codes and Guides applicable for the project location. Applicable documents include, but are not limited to, the latest version of all standards, codes and as well as all applicable sections and referenced standards within. Where conflicting information is presented, compliance with the most stringent of the conflicting standard, code, and/or guide is required.
  - 1. Global Standards
    - a. International Organization for Standardization (ISO) Standards:
      - 1) ISO 9001 Quality Management Systems Requirements
      - 2) ISO 10005 Quality Management Systems. Guidelines for Quality Plans
    - b. Standards of International Code Council (ICC)
      - 1) International Building Code (IBC)
      - 2) ICC AC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
    - c. Institute of Electrical and Electronics Engineers (IEEE)
      - 1) IEEE 1159.3, Recommended Practice for the Transfer of Power Quality Data
  - 2. Additional Standards for Sites in the USA
    - a. National Fire Protection Association
      - 1) NFPA-70, NEC
    - b. National Electrical Manufacturers Association (NEMA), in particular:
      - 1) NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
    - c. American National Standards Institute (ANSI), in particular:
      - 1) ANSI C2 The National Electrical Safety Code
    - d. Institute of Electrical and Electronics Engineers (IEEE)
      - 1) C2 National Electric Safety Code (NESC)
    - e. American Society of Testing and Materials (ASTM)
      - 1) D 3951 Standard Practice for Commercial Packaging
    - f. Underwriters Laboratories Inc. (UL) Safety Standards
      - 1) UL 347 High Voltage Industrial Control Equipment
      - 2) UL 467 Grounding and Bonding Equipment
- B. In addition, compliance with requirements of the local code authority having jurisdiction (A.H.J.) shall also be included if the A.H.J. requirements affect the manufacturing of the equipment.
- C. Project Contract Documents
  - 1. Drawings: Wherever the terms "Plans" or "Drawings" are used in these specifications, they shall refer to the Issued for Construction Drawings for this project. The equipment proposed to be furnished under these specifications shall

be compatible with the space provisions, wiring configurations and other requirements as shown on these Drawings.

- 2. Specifications. Other Contract specifications and documents contain information related to the equipment the services specified herein. Some are listed below:
  - a. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - b. Division 26
    - 1) 26 05 **xx** Common Work Results for Electrical, set of specifications
    - 2) 26 08 00 Electrical Systems Commissioning Requirements
    - 3) 26 12 16 Dry-Type Medium Voltage Transformer
    - 4) 26 13 03 Medium Voltage Circuit Breaker Switchgear
    - 5) 26 23 13 Low Voltage Switchgear
    - 6) 26 32 13 Medium Voltage Diesel-Engine-Driven Generator Sets
    - 7) 26 33 23 Central Battery System (Station Service)
    - 8) 26 12 19 Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
    - 9) Sketches and supporting materials attached to this package and part of the IFC set including: protection details; cable requirements; replacement strategy and others.
- D. Equipment submittals from other Suppliers

### 1.3 SUMMARY

- A. Section Includes:
  - 1. Metal-clad Service paralleling and output distribution switchgear rated 4160 V.
  - 2. Surge suppression devices.
  - 3. Disconnecting and overcurrent protective devices.
  - 4. Instrumentation.
  - 5. Controls (PLC's, HMI) and control power.
  - 6. Accessory components and features.
  - 7. Identification.
  - 8. Remote Monitoring
  - 9. Mimic bus.
- B. General:
  - 1. It is the intent and purpose of these specifications to provide a complete freestanding OutputMain - UtilityMain - GeneratorMain - Gen - Gen - Gen - Gen - GeneratorMain - UtilityMain - OutputMain switchgear assembly containing circuit breakers and control devices for the operation, control and paralleling three sets of standby duty MV diesel engine-generators with associated utility source and for power distribution to the facility. The system shall be of the latest commercial type and design and shall be arranged for fully automatic or manual operation of the following power sources:
- C. Name Qty. Prime Mover KW/KVA Volts PF. FLA. Hz.

Gen-EG1	1	Diesel	2000/2500	4160V	.8	347	60
(F) Gen-EG2	1	Diesel	2000/2500	4160V	.8	347	60
(F) Gen-EG3	1	Diesel	2000/2500	4160V	.8	347	60
Utility-A	1	PGE XFR	2500/3333	4160V		462	60
Utility-B	1	PGE XFR	2500/3333	4160V		462	60

- D. Each end of the switchgear system shall be able to parallel with the utility and/or operate as a standard closed-transition automatic transfer switch.
- E. The generator/ switchgear system shall automatically start, attain rated speed and voltage, accept load and be able to supply continuous electrical service within 10 seconds after the beginning of an interruption of the normal power and shall allow for unattended operation for the duration of a normal power outage.
- F. The switchgear shall consist of full height, indoor, NEMA 1 type metal-clad switchgear with generator sources, normal utility power main circuit breakers, generator main circuit breakers, buswork, protective relays, customer metering, monitoring/control devices, remote annunciation contacts and automatic engine-generator controls, arranged as shown on the drawings.
- G. Refer to single-line diagram, drawing EE5.1 for additional information.

### 1.4 SCOPE OF RESPONSIBILITY

- A. The switchgear supplier shall be responsible for the interface and coordination between the paralleling switchgear and the generator vendors to ensure that all controls and equipment supplied is compatible with those generators.
- B. The switchgear supplier shall be responsible for the interface and coordination between the paralleling switchgear and any requirements from PG&E related to 100mS closed-transition transfers to ensure that all controls and equipment supplied is compatible and approved by PG&E.
- C. All items specified below shall be completely assembled by a single manufacturer, and be UL listed and labeled by the same manufacturer to assure identical construction and control wiring.
- D. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

#### 1.5 DEFINITIONS

- A. See Specification Section "01 42 16 Definitions" for project definitions.
- B. See Specification Section "01 42 13.13 Equipment Abbreviations" for equipment abbreviations
- C. The following terms appearing in this specification section shall have the following meanings:
  - 1. "ECU" refers to Engine Control Unit
  - 2. "EPO" refers to Emergency Power Off
  - 3. "GCP" refers to Generator Control Panel

### 1.6 SYSTEM DESCRIPTION, DESIGN AND PERFORMANCE REQUIREMENTS

- A. The MV Generator Paralleling Switchgear (MVGPS) specified herein shall control the Medium Voltage Power System starting from the connection to the Utility all the way down to the Medium Voltage distribution switchgear and include control of MV diesel-engine driven generating sets.
- B. Data Acquisition and Validation. The system shall have the required input/output modules and communication interfaces to acquire all necessary data, process it and validate it. Data validation subroutines shall use not only the information from the particular input or output module, signal, instrumentation and wiring, but all other metering and related data to validate the truthfulness of the signal.
- C. Control. The system shall provide the following levels of control:
  - 1. Oversee and interface local control executed at generators provided by the generator Supplier
  - 2. Manual control from local MVGPS Interface
  - 3. Automatic Control
  - 4. Manually Initiated Automatic Control
  - 5. Manually Initiated Automated Maintenance Sequence to allow for isolating MV Switchgear or other equipment for maintenance.
  - 6. Generator controls for MV Generators in Paralleling arrangement. For paralleling systems, the MVGPS shall provide paralleling and synchronization, open transition, closed transition with 100mS maximum overlap, automatic load shedding, and generator optimization (when two other generators are installed).
- D. HMI and Monitoring.
  - 1. Local: mounted on Paralleling Switchgear, utilizing touchscreen display.
  - 2. Remote: mounted on wall in Owner's engineering Office, utilizing touchscreen display. Connected via fiber optic cable.
  - 3. The system shall provide operations personnel with monitoring and control of the MVGPS, including but not limited to:
    - a. Graphic user interface with displays depicting systems and equipment and showing system configuration, status of equipment, metering information, etc.
    - b. Receiving, event logging, and notification of alarms and power quality events.
    - c. Real-time trending, data archiving, and retrieval of any or all selected historical data, include additional memory in PLC for 1-year's worth of data.
    - d. Timely and secure access and display of the above information
    - e. Generate reports to document performance and events.
- E. Time synchronization: NTP-based synchronization signal to devices, controllers and head end. Sequence of event recording is not required.
- F. Equipment, hardware, interfaces, integration, software and application software specified herein shall be provided for a fully integrated, safe, dependable, and properly functioning MV Generator paralleling switchgear System.
- G. Workmanship shall be of the best quality, free from any defects that might render the equipment or software unreliable, unsuitable, or inefficient for this critical application. Best quality practices should be documented and followed, verification of these procedures should be provided to the Owner, if requested.

- H. Seismic-Restraint Design: Assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces in accordance with the requirements for the specific project location defined in Specification 018116 Environmental Requirements.
- I. Nomenclature and Identification. Follow the latest revision of Specification 01 42 09 Nomenclature and Identification for document identification, labeling cabling, equipment and components. The Supplier shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation in accordance with the Owner's requirements. All information shall be provided in electronic format to be approved by the Engineer.
- J. Limiting Physical Dimensions. Please refer to the electrical and switchgear room layout drawings for details of limiting dimensions. The dimensions indicated on the drawings indicate the space allowances available and shall not be exceeded. Any non-conformance with the dimensions shown shall be identified by the Supplier at the time of Bid. Any costs associated with size changes after contract award shall be borne by the Supplier. The physical dimensions shall not limit the maintainability of the switchgear. Dimensions of shipping splits shall be determined to be compliant with local shipping requirements.
- K. Reliability. As the intended use of the MVGPS is to achieve the ultimate reliability of availability of power to critical loads using available power paths, it is required that MVGPS hardware or software do not introduce additional failure contributions that would interfere with maintenance of power to the load, as long as there are power sources and generators available.
- L. Maintainability
  - 1. Concurrent Maintainability:
    - a. Hardware and software shall be designed with redundancies and features to allow for safe isolation and removal from service for maintenance, expansions, and repairs and returned to service without impacting any of the monitoring and control functionality.
  - 2. The Supplier shall incorporate the following maintainability design concepts:
    - a. Equipment and accessories specified herein shall be designed for a life expectancy of 30 years as a minimum.
    - b. Full life cycle costs shall be considered including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified herein.
    - c. Materials shall be selected to provide corrosion- and wear-resistance protection that is adequate for the environment and service. Should a material not be replaceable with a corrosion resistant one, the susceptibility shall be mitigated with coatings as appropriate for the environment as described in this specification.
    - d. The equipment shall be able to be moved via a pallet in order to minimize the need to utilize excessive manpower or cranes for maintenance. In the event the equipment is too large or heavy to be transported via a pallet, manufacturer shall include lifting lugs and other equipment for handling bulky, heavy, and difficult to maneuver items.
    - e. Components likely to require replacement or emergency repairs shall be readily accessible and clearly marked. Such components shall be mounted in pull-out drawers, mounted on DIN rails and/or connected by quick

disconnect fittings. Test points or terminals for maintenance shall be included. If special tools are required for maintenance, they should be provided for each assembly location.

- f. Electronic components shall be protected against power fluctuations and electrical discharges.
- g. The need to conduct periodic physical inspections shall be minimized, and equipment status and condition shall, in as far as it is practical, be remotely monitored. Where checking of the health and status of working equipment is necessary, the Supplier shall incorporate methods of inspection that can be accommodated without the need to power-down the equipment under inspection and / or the location from where the inspection is to be undertaken.
- h. The design shall be made so that recalibration and cleaning requirements are minimized and can be conducted during properly scheduled maintenance periods.
- M. Fault-Tolerant Design. The system shall be fault-tolerant and fully functional in the event of a planned outage or unplanned failure of any individual component, system control assembly, system control processor, input/output module or communications component or pathway.

# 1.7 SYSTEM INTEGRATION

- A. The equipment and software supplied herein shall interface with equipment from other Suppliers to form a fully integrated, functional, resilient and concurrently maintainable Power Distribution Control System. Liaise with the other equipment Suppliers to coordinate the interface with their systems, provide necessary technical information and ensure a fully integrated system.
- B. The required equipment and systems to be integrated by the Supplier include, but are not limited to:
  - 1. Diesel-Engine-Driven Generator Sets and Generator Controls
  - 2. Diesel Engine Particulate Filters DPF), Selective Catalytic Reduction (SCR) filtration system
  - 3. Medium Voltage Switchgear Paralleling & Distribution
- C. Medium Voltage Switchgear Integration. The MVGPS Supplier shall be responsible for coordinating the designs and the integration of the MV Switchgear and shall liaise with the MV Switchgear Supplier to ensure a fully integrated Medium Voltage Power Distribution System. Details on products supplied with the MV Switchgear are as specified in Section 26 13 13 Medium Voltage CB Switchgear.
  - 1. Breaker control interface
  - 2. Hardwired interlocks
  - 3. Protective Relaying
  - 4. Power Quality Metering
  - 5. Paralleling and closed transition loading
- D. Diesel-Engine-Driven Generator Sets Integration. The MVGPS Supplier shall be responsible for coordinating the designs and the integration of the MV Diesel-Engine-Driven Generator Sets and shall liaise with the Generator Sets Supplier to ensure a fully integrated Medium Voltage Power Distribution System. Details on products supplied with the Generator Sets are as specified in Section 263213.13 Diesel-Engine-Driven Generator Sets. As a minimum coordinate and integrate:

- 1. Generator Set Controllers for engine protection, power metering, controls and monitoring, paralleling, synchronizing, loading and unloading. System shall be designed and implemented to comply with utility company requirements for 100 mSec maximum duration.
- E. The MVGPS Supplier shall produce field interconnect wiring organization and documentation, for those controls required between the switchgear and equipment supplied by others.
- F. The MVGPS Supplier shall coordinate the interface with the Switchgear supplier to coordinate the necessary interfaces between controls and switchgear components.

# 1.8 REMOTE NOTIFICATION OF ALARMS

- A. The MVGPS PLC shall include the following system for remote notification of alarms (e.g. breaker tripped due to overcurrent):
- B. Email: The PLC System shall send an email to designated recipients in the event of an alarm.
- C. SMS: The PLC System shall send an SMS to designated recipients in the event of an alarm.
- D. Push Notifications: The PLC System shall use a push notification on a mobile app in the event of an alarm.
- E. Time for coordination with Owner and programming of the above systems shall be included.
- F. The system shall provide interface to Owner's LAN/ internet connected computers for remote emailing and texting only of alarm and status change messages remote control is strictly forbidden, and Red Lion device shall not allow any cyber breach or tunneling into the PLC system.
- G. Remote Monitoring Interface Network. Simple Ethernet over fiber-optic cabling to existing Owner's LAN. Provide fiber network interface card on PLC or HMI to provide the connection. Final Port connection method at the Owner's end shall be as directed by the Owner. Final connection can be copper downstream of a media converter or Fiber-optic cabling directly connected to an Owner's fiber port. Owner to decide during installation. Provide all infrastructure, cabling, media converters, programming, etc. as required via the services of a Structured cabling contractor. Programming of the Red Lion email and SMS device shall be under this MVGPS contract.

# 1.9 SUBMITTALS

- 1. Languages. English.
- 2. All drawings and data shall be identified by the Owner's project name, job location, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each drawing shall be made by such means as a triangle-enclosed revision number.
- 3. The Suppliers shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation. All information shall be provided in electronic format to be approved by the Engineer.
- 4. Electronic format.
  - a. File names shall be intuitive and clearly identify the document.

- b. All documents are required to be provided as ISO Portable Data Format (PDF) files.
- 5. Submittal Process. The Owner may request uploading to an online file storage system such as Box or if some of the systems are not fully functional. Approval of a submittal does not warrant an acceptance of the equipment. If the requirements are not met the submittal may be rejected without review or comments.
- 6. All conflicts and discrepancies between the requirements of this Specification, Drawings, codes and standards and Purchase Order shall be referred to Engineer and the Owner for clarification before proceeding with the manufacturing of the affected parts.
- B. Bid Submittal. Following the requirements herein, as a minimum, provide the information listed below in electronic format in English language. Failure to submit this information with the bid shall cause the bid to be rejected as non-responsive.
  - 1. Technical Offer:
    - a. A narrative describing the proposed solution including any value engineering or alternative cost options.
    - b. Itemized Specification compliance response. The response shall include a copy of these Specifications, including all Appendices with each paragraph noted with the comment, "C" for Compliance, "D" for Deviation, and "E" for Exception. Additionally, a filled in Numbers or Excel spreadsheet shall be provided listing the paragraphs noted with deviation or exception and providing additional detail on the scope and reasons for the deviation/exception. Failure to submit this information with the bid shall cause the bid to be rejected as non-responsive. The definition of these terms appears below:
      - 1) "C": By stating "compliance", the Supplier agrees to furnish the item or the feature as specified with no variation.
      - 2) "D": By stating "deviation", the Supplier proposes to furnish the item or the feature in a different way, while still meeting or exceeding the intended purpose of the product. The Manufacturer shall describe the reason for the deviation and the advantages/disadvantages of the proposed solution. Deviation should clearly reference specification section and line item. Stating deviation does not mean or imply acceptance.
      - 3) "E": By stating "exception", the Supplier's intention is not to furnish the item, the feature or the services specified. The Manufacturer shall describe the reason for the exception. Exemption should clearly reference specification section and line item. Stating exception does not mean or imply acceptance.
      - 4) If nothing is stated, it is assumed that the Supplier states "compliance". If there are contradictions in the statements, it is assumed that the statement that favors the Owner takes precedence.
    - c. Drawings and Design Data including but not limited to:
      - 1) Dimensions, weights and clearances.
      - 2) Single line diagrams.
      - 3) Communication and vendor's internal network diagrams

- 4) Data sheets providing as a minimum the parameters listed in the specification.
- 5) Bill of materials.
- 6) Modes of operation and sequence of operation for each mode.
- 7) Draft interface diagrams and point counts.
- 8) PLC programming logic files and printouts in electronic format
- d. Suppliers/Manufacturers of all major components including generation/product line.
- e. Instruction Manual for Installation.
- f. Declaration of Conformity and product certifications.
- g. Type test reports.
- h. Catalog data of proposed equipment.
- i. Product recalls by category for the past 10 years.
- j. Supporting product information necessary to understand the technical solution.
- 2. Maintenance
  - a. Recommended extra materials and spare parts, including pricing.
  - b. Maintenance schedule, including pricing for annual cost of service.
- C. Progress Reports. Starting with Award, the Supplier shall submit a Project Progress Report, on a monthly basis as a minimum and more frequently if required. Each report, shall contain the following, as a minimum:
  - 1. Progress during the period. Briefly describe the activities that have taken place during the period.
  - 2. Upcoming activities. Briefly describe upcoming activities and highlight action items required by the Owner, Contractor or Engineer.
  - 3. Percent complete for each part of the order.
  - 4. Project schedule status. Attach project schedule and highlight any significant changes that may impact the overall project schedule.
  - 5. Project change log. Document any changes to the scope of work.
  - 6. Project risks management and issues. Document any potential risks to the project including cost, schedule, quality, interface with other Suppliers and the Contractor, etc.
- D. Prior to Fabrication Submittal. Manufacturer's drawings and design documents shall be submitted for approval using the project Document/Construction management system within 30 days of issuance of a purchase order. The Manufacturer shall proceed with fabrication or assembly of equipment only after approval of the drawings or authorization to proceed. The Owner reserves the right to make changes in requirements until the Supplier's drawings are returned approved. The Owner may provide partial approval to facilitate procurement of long lead time components, while finalizing detailed shop drawings. Submittal shall include as a minimum:
  - 1. System description including an overview of the system, hardware description, network and communication description and architecture, and application software description and architecture.
  - 2. Software licenses. Provide a complete list of the software licenses required for a complete and functional package, including development software, operating systems, software tools, etc.

- 3. Updated Compliance-Deviation-Exception (CDE) form listing the agreed in the contract deviations and exceptions and any additional deviations and exceptions based on the final product design in both PDF. New deviations and exceptions shall be clearly identified do distinguish between the accepted with the contract ones.
- 4. Panel fabrication drawings and documents:
  - a. Plans, elevations, sections and details showing dimensions, minimum clearances, entry provisions for field connections, gutter space, installed features and devices, weights, center of gravity, lifting and handling provisions and requirements, for each assembly specified. Specifications for the method of placing and anchoring the equipment to the building structure, including an indication of the highest UBC Seismic Zone for which anchorage method is rated.
  - b. Single and three-line diagrams.
  - c. Internal wiring diagrams.
  - d. Control wiring termination drawings for field connections.
  - e. Control Power and Auxiliary Power wiring termination drawings for field connections.
  - f. Bill of Materials. A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the system. Bills of material shall include all items within an enclosure.
  - g. Manufactured (integrated) product data sheets for each component. Include data on features, components, ratings, physical, mechanical and electrical characteristics and performance. Provide data for parameters listed in APPENDIX A: RATINGS.
  - h. Spare parts list
- 5. Panel heat load and cooling requirements
- 6. Power calculations and requirements for both control power from the station DC battery system and any required auxiliary power for lighting, heaters, etc.
- 7. Communications and Network Diagrams and Documents
  - a. Communication and network diagrams showing all devices interfaced via serial link, RS485 network or connected to the Ethernet network.
  - b. Network wiring termination drawings for field connections
  - c. Network device list, including devices furnished by the Supplier and all devices furnished by other equipment Suppliers for the project that are connected to the MVGPS.
  - d. Network Switch Port Allocation. Liaise with the Owner and the MVGPS Supplier to develop port allocation document to determine how the remote monitoring via email and SMS will safely interface to the owner's LAN.
  - e. Communication registers and maps including interface with equipment and systems furnished by other Suppliers for the project.
- 8. Integration Design Package. Drawings and documents required to integrate equipment provided by other Suppliers and ensure that signals and communications are provided, installed and tested.
  - a. Hardwired interlocks, inhibits and permissives.
  - b. Complete point lists including hardwired and communication input/outputs and calculated points.
  - c. Point-to-point wiring diagrams of all circuits, showing connections to each piece of equipment. Wiring diagrams shall clearly show the interface to equipment provided by other Suppliers, including device names and terminal identifications. Diagrams for wiring internal to the equipment

furnished by other Suppliers are not required to be included as part of this submittal.

- 9. Application Software Design Package
  - a. Application Software description, approach and software architecture
  - b. Levels of control including: local manual, MVGPS manual at panel, MVGPS manual at remote panel, automatic, maintenance, etc.
  - c. A draft Sequence of Operation (SOO), including a detailed description of the modes of operation and sequence of operation for each mode. The SOO shall include the description of all hardwired and software interlocks, inhibits and persmissives.
  - d. Graphic Displays.
    - 1) List of graphic displays to be provided for the project, including active single-line diagrams, device detail screens, device type summary screens, KPI screens, control screens, etc.
    - 2) Menus and navigation structure
  - e. Events Recording and Alarm System design including assignments of points, levels of alarming, etc.
  - f. Reporting design listing the required reports and the approach to reporting
  - g. Notification system design
  - h. Application Software Test approach
- 10. Factory test procedures, scripts, test matrices and checklists. Submitted procedures shall be detailed and project specific.
- 11. Preliminary Installation, Operation and Maintenance Instructions and Manuals.
- E. Prior to Level 1 Commissioning Factory Acceptance Test Submittals. Documents shall be submitted by the Manufacturer using the project Document/Construction management system when required by the Contractor and the construction schedule, but no later than 30 days prior to factory acceptance testing. As a minimum the following items shall be provided:
  - 1. Updated documents and drawings from Prior to Fabrication Submittal including sequence of operations, graphic displays, point lists with logging, alarming, historian and other required parameters for each point, reporting, etc.
  - 2. Final Level 1 test procedures, scripts, matrices and checklists
  - 3. Configuration files and application programming required for the system
- F. Prior to Installation Submittals. Installation, Operation and Maintenance Instructions and Manuals, relevant fabrication drawings, settings and program sequences shall be submitted by the Supplier using the project Document/Construction management system when required by the Contractor and the construction schedule, but no later than 30 days prior to initial shipment. As a minimum the following items shall be provided:
  - 1. All information required for handling; installation; connecting of power, control and network wiring; start up and commissioning; maintenance; and operation of the supplied equipment.
    - a. Maintenance instructions for each type of equipment, each device type, and for the complete arrangement of equipment and devices supplied.
    - b. Detailed descriptive instructions of the operation of the equipment or device, manufacturer's literature, detailed wiring diagrams, device internal wiring diagrams and electrical characteristics.

- c. MVGPS Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing settings and variables.
- d. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
- 2. Updated to "As manufactured" state shop drawing and other relevant information from Prior to Fabrication and Prior to Level 1 Commissioning submittals, including, but not limited to:
  - a. An updated SOO with detailed description of the modes of operation and sequence of operation for each mode.
  - b. List of all factory settings of all intelligent devices together with configuration/programming instructions and software for each type of device.
  - c. Factory acceptance test reports and calibration records for devices and instrumentation together with calibration instructions and software for each type of device.
- 3. Coordination of installation required for the connection of the remote LAN and Remote monitoring panel, including, but not limited to:
  - a. Plans showing all equipment locations coordinated with the work of other trades and routing of all cables
  - b. Details of the cable and wiring terminations at each device for each wire run.
  - c. Data sheets of equipment being furnished for installation by the contractor, such as media converters.
- 4. Final Level 2 and Level 3 Commissioning test procedures, scripts, matrices and checklists
- 5. Preventive maintenance schedule with detailed instructions and procedures for each maintenance activity.
- 6. Training plan and detailed descriptions of training topics.
- G. Prior to Final Acceptance Submittals. After commissioning and prior to taking over, as a minimum, the following items shall be submitted by the Manufacturer using the project Document/Construction management system when required by the Contractor and the construction schedule, but no later than 30 days after commissioning of the equipment.
  - 1. Updated to "As built" state drawings and documents provided under previously provided Submittal.
  - 2. Updated and final Installation, Operation and Maintenance instructions provided under Prior to Installation Submittals.
  - 3. Copies of completed factory and site testing reports including records of final settings and calibration.
  - 4. For all intelligent Devices, including, but not limited to: relays, meters, controllers, sequence of event recorders, network equipment, workstations, servers, etc., provide:
    - a. Latest firmware revisions downloaded to the devices with a revision control system including a device list and the latest firmware version.
    - b. Latest operating systems, software tools and applications and required licenses.

- 5. Final application software and configuration files for each controller and intelligent device part of the system. Final HMI, Historian, Alarming, Reporting server application files. All files shall be in their native format.
- 6. Equipment warranties and contact information for warranty matters.
- 7. Final Compliance-Deviation-Exception (CDE) form listing the agreed in the contract deviations and exceptions and any additional deviations and exceptions based on the "as built" condition in both PDF and native format. Deviations and/or exceptions shall clearly reference specification section and line item.
- H. Requests for Information (RFIs). If the Supplier needs to clarity the design intent or discrepancies within the documentation, RFIs can be submitted through the Project Document/Construction Management System. RFIs shall not be used to propose alternative design solutions or for Change Orders. Each RFI shall clearly identify the Drawing or specification number, revision, date, section number and page relating to the clarity. A separate RFI shall be raised for each clarity.

# 1.10 QUALITY ASSURANCE

- A. Conformity and compliance. Electrical Components, Devices, and Accessories shall be listed and marked as follows:
  - 1. USA: Electrical Components, Devices, and Accessories: Listed and labeled, per NFPA 70 Article 100, by a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 and which is acceptable to the authority-having-jurisdiction and marked for intended use.
- B. Manufacturer Qualifications:
  - 1. The Supplier of equipment and software shall have been regularly engaged in the controls field for a period of at least ten (10) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications.
  - 2. The Supplier shall maintain a local service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight (8) hours from time of notification.
  - 3. The manufacturer shall submit a reference list of existing operating installations, including major facilities, each having a minimum of 30 remote devices with a similar or larger control scope
- C. All equipment, material, work and testing supplied shall be in accordance with the latest edition and amendments of all applicable standards, codes, laws and regulations reference in paragraph 1.2.
- D. The Supplier shall participate in coordination meetings to ensure understanding of functional and installation requirements impacting the design and coordinate project sequencing and scheduling.

# 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Identify shipment with Company's purchase order number, Owner project name, and unit/tag number, following the project naming convention.
- B. Ship all equipment properly packed in tightly sealed, heavy gauge plastic or other type of liquid proof cover to protect the equipment from handling, shock, vibration, corrosion, rain, dust, and other foreign material.

- C. Sensitive to the environment equipment shipped separately or as a part of a bigger assembly shall be sealed and protected for any physical or environmental degradation or damage during shipping and storage.
- D. When assemblies are supplied that require disassembly for installation or are shipped disassembled, each piece of the subassembly so affected will be uniquely identified as to its assembly position.
- E. Box, crate or otherwise completely enclose and protect any loose components and spare parts. Clearly mark all equipment and provide complete installation instructions for any parts shipped separately from the main assembly.
- F. Adequately brace each shipping unit and its components, both internally and externally to prevent damage during shipping, handling, storage or in the process of erection.
- G. Clearly mark all shipping blocks, binding, braces, supports, etc. so that removal is assured. Identify any special precautions that must be observed when removing shipping constraints.
- H. Provide all shipping units with provisions for lifting and or skidding into place. Clearly mark all lifting points.
- I. Furnish unique installation materials and tools where required for the installation and commissioning of the equipment.
- J. Ship equipment by truck via direct dedicated carrier to job site. Coordinate the delivery with the Contractor and the Installing contractor with proper notifications for status of delivery. Installing contractor will be responsible for unloading and placing equipment at its final location under the Manufacturer's supervision.
- K. The Supplier shall be responsible for the repair or replacement at their expense of all damage due to improper preparation, packing or damage while in transport.
- L. The Contractor shall be responsible for receiving, inspecting and storing the equipment until installation. The specified equipment shall be kept dry and clean at all times. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

# 1.12 SITE CONDITIONS

A. The supplied equipment and systems shall be designed for the site conditions. See Specification 01 81 16 Facility Environmental Requirements for site data and environmental conditions.

# 1.13 CYBERSECURITY

A. The Supplier must provide software and PLC's that prevent hacking or other outside cybersecurity control issues.

# 1.14 SEQUENCING AND SCHEDULING

A. The Supplier shall be responsible to coordinate production, testing and delivery schedule with the Contractor, Engineer, Commissioning Authority and the Owner to ensure on-time delivery of the equipment coordinated with the project construction schedule. The Supplier shall provide regular schedule updates and notifications for potential schedule delays.

- B. The Contractor shall provide up to date project schedules to the Supplier on a regular basis and on a monthly basis as a minimum.
- C. The Supplier is responsible for timely transfer of all software tools, utilities, and licenses required for on-site implementation and testing of the system to the owner for installation on secure laptop(s).

# 1.15 WARRANTY

- A. Warranty the specified equipment and all other associated equipment (excluding batteries) as specified herein to be free from defects in materials, workmanship and non-performance per the requirements of this Specification for a minimum of 2 years after written acceptance by the Owner. In the event, any defects are discovered by the Owner within 2 years from acceptance of such equipment, the Manufacturer shall repair or replace, at Owner's option, defective products at no cost to the Owner. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.
- B. If at any time during the first two (2) years of commercial operation as defined below, the Owner shall accumulate sufficient evidence to reasonably indicate that the equipment or any part thereof is not in accordance with the specifications, the Owner will so notify the Supplier in writing, and the Supplier shall repair or replace the defective components. The cost of removal, reinstallation and complete re-testing of the equipment and any associated freight charges or service engineering charges, shall be at the Supplier's expense. The guarantee for the repaired or replaced equipment shall be extended for one year from the completion of repairs or replacement.
- C. If the equipment fails to meet the specific performance guarantees, the Supplier shall recommend to the Owner adjustments or modification. Upon approval by the Owner, the adjustments or modifications shall be made, and tests shall be rerun. The cost of these adjustments or modifications and complete re-testing shall be made at the Supplier's expense. After such adjustments or modifications, should the equipment fail to achieve the guaranteed performance, an equitable settlement shall be made which may, without limitation, include an adjustment of the contract price.
- D. Complete re-testing, as referred to in this section shall mean site acceptance testing as stipulated in testing portions of this specification. The conditions that apply to original testing requirements shall also apply to the re-testing of any equipment performed under the conditions of this guarantee.
- E. Commercial operation is defined as commencing on the date on which the equipment covered by these specifications has successfully completed final site acceptance testing and has received written acceptance by the Owner.
- F. Furnish warranty covering all costs for repair, parts, labor, testing equipment, travel, and living expenses for the manufacturer's service personnel. Performance of warranty work shall not be restricted to normal working hours but shall be at the Owners choosing including overtime and weekend hours at no additional cost to the Owner.
- G. Service Response Time required to provide service on a 24-hour, seven days a week basis by a factory trained field service engineer with:
  - 1. Phone Support within 15 minutes of initial call by Owner or owner's representatives
- 2. On-site support within 12 hours of initial call by Owner or owner's representatives
- 3. Be fully capable of providing high-quality, factory-trained service personnel and Manufacturer-certified replacement parts.
- 4. All service reports shall be provided to the local site facilities engineer within 1 week of any site visit.
- H. Establish and maintain procedures for:
  - 1. Qualification/certification of field service technicians.
  - 2. Escalation of field service problems to Manufacturer's engineering support when required to back up field service technicians.
  - 3. Document and software/firmware version control.
  - 4. Spare parts inventory control.
  - 5. Customer notification of Manufacturer's equipment upgrades and product service alert bulletins.
- I. Replacement parts shall be of the same manufacture as provided by the original Supplier.
- J. The name, address and twenty-four (24) hour telephone number of the nearest authorized service organization shall be displayed on the inside of the door of each enclosure.
- 1.16 WARRANTY
  - A. Manufacturer shall warrant the equipment for 24 months from date of shipment.
- 1.17 MAINTENANCE:
  - A. Provide a one-year manufacturer's maintenance contract of the MVGPS system. The one-year period shall begin from the date of Engineer's acceptance on a total no charge basis. During this period, manufacturer's maintenance staff shall visit the installation not less than two times for routine inspection and preventive maintenance. The maintenance visits shall be scheduled at 6-month intervals and shall be coordinated with the Owner and performed at times selected by the Owner. A written report of each maintenance visit shall be submitted to the Owner within 10-days. The manufacturers shall submit a preventative maintenance schedule outlining in detail the following:
    - 1. Time when services are to be performed.
    - 2. Work to be performed.
    - 3. Shutdowns required for service.
    - 4. Company or electrical contractor support services required.
  - B. The contract shall include, but not be limited to, the following:
    - 1. MVGPS manufacturer's recommended procedures for semi-annual inspection and maintenance.
    - 2. Quarterly inspection by the supplier personnel to review the weekly maintenance records being kept by user and train any new owner operating personnel.
    - 3. Annual inspection shall include all of items in paragraph a. and b. and shall also include all recommended annual maintenance.
    - 4. The manufacturers shall not deviate or take exception to these requirements.

# 1.18 SYSTEM START UP AND COMMISSIONING

A. Level 1 – Fabrication

- 1. Level 1a Factory Acceptance Test (FAT)/ Factory Witnessed Test (FWT) for MVGPS/ MVDSA/B at Supplier's facility
  - a. General
    - 1) The Supplier shall develop and perform routine, failover and any additional tests specified herein and required to validate hardware performance, ensure that the equipment conforms to codes, standards and Owner's equipment specification.
    - 2) The Supplier shall develop and perform application software testing to validate data processing and validation, Sequence of Operations, HMI, etc. Initial Sequence of Operations is provided in Appendix. Third party equipment including MV switchgear and diesel-engine driven generators shall be simulated.
  - b. FAT. The Supplier shall perform the required above tests, document the results and submit the reports to the Owner, the Engineer and the Commissioning Agent for review.
  - c. FWT. After the initial FAT performed by the Supplier, the Owner and/or its representatives, the Engineer and the Commissioning Agent will witness in person a portion or the whole factory acceptance test. The scope and duration of the FWT shall be coordinated to avoid repetition of destructive testing and minimize wear and tear on equipment. Equipment and personnel shall be scheduled on the factory floor, prepared to minimize any idle time.
- 2. Level 1b FAT/FWT for Integration at Switchgear Manufacturing Facility
  - a. The Supplier shall liaise with the MV Supplier to perform testing at their facility. As a minimum the testing shall include the pertinent parts of the MVGPS, paralleling switchgear and the transfer switchgear to prove the SOO implementation and the interfaces with the switchgear. Required interfaces to other equipment and devices shall be simulated.
  - b. FAT. The Supplier shall perform the required above tests, document the results. In the interest of time reports can be submitted after the FWT.
  - c. FWT. After the initial FAT performed by the Supplier, the Owner and/or its representatives, the Engineer and the Commissioning Agent will witness in person the factory acceptance test. The scope and duration of the FWT shall be coordinated. Equipment and personnel shall be scheduled on the factory floor, prepared to minimize any idle time.
- B. Level 2 Equipment Installation the General Contractor (GC) shall have processes to ensure the equipment is received, stored, installed and made ready for the equipment Supplier to perform their site startup.
- C. Level 3
  - 1. Supplier Equipment Startup the equipment Supplier shall have procedures and methods to ensure the supplied equipment is started, adjusted and performance is validated on site.
  - 2. Remote Monitoring Integration the Supplier shall validate integration of all devices connected to the Owner's LAN are communicating, reporting and meeting the performance requirements.
  - 3. Supplier Integration Validation the Supplier shall check and validate that all third-party equipment and signals are integrated and perform per design and requirements.

- 4. Supplier local and remote HMI validation and verification the Supplier shall validate performance of local full license HMI workstations.
- D. Level 4 Equipment Specific Commissioning The Supplier, Contractor and Owner CxA shall coordinate the validation of the installed equipment. The CxA shall direct the commissioning test with the assistance and support of the Contractor and the Supplier.
- E. Level 5 Integrated System Testing The Owner CxA shall develop tests that ensure multiple systems, subsystems and components work as integrated systems. The Contractor and Supplier(s) shall assist and support these tests.
- F. The Owner CxA will review test reports, partially or completely witness tests performed by other entities and validate completion of the required of each level tests and verifications. The GC and Supplier cannot proceed with the next level without authorization/tagging of the pertinent equipment.

# 1.19 MAINTENANCE

- A. Extra Materials and Spare Parts
  - 1. Manufacturer to develop list of recommended extra materials and spare parts. List to include per unit pricing.
  - 2. Provide a portable lift truck for removal and transport of medium voltage circuit breakers.
- B. Maintenance Service
  - 1. Manufacturer to develop recommended maintenance schedule and procedure with detailed instructions.
  - 2. Maintenance: Upgrades, revisions, service packs and updates to hardware, firmware, or application software issued by the manufacturer during the Warranty period for products provided under this contract shall be provided, installed, tested and documented for the end-user as part of this contract. Customer and end-user shall be notified in writing of the availability of such improvements and the implementation shall be performed at a mutually agreed-upon time.

# 1.20 TEST MODE DESCRIPTION OF OPERATION

- A. The test mode programming shall include the project's generators.
- B. The local HMI shall be equipped with a two-position, TEST/AUTO soft switch and a two-position "NO-LOAD TEST/TEST WITH LOAD" soft switch.
- C. Selecting the "TEST/AUTO" switch to the "TEST" position shall:
  - 1. Operate an amber indicator labeled "TEST MODE." This indicating symbol shall be located on the bottom of all screens to constantly alert owner of the operating mode status.
  - 2. Initiate a specific test depending on the position of the two-position switch.
  - 3. Log event in the MVGPS system, indicating that the TEST/AUTO switch is in the Test position.
  - 4. In the "AUTO" position, the system stands ready to start generator upon a loss of normal power. If the system was operating in the "TEST" Mode, and the switch is returned to the "AUTO" position, then the system shall:
    - a. Perform a normal shutdown as described under the Automatic Mode section under "Return of Normal Power".
    - b. If a loss of normal power occurs when operating in the "TEST" mode, the system shall:

- 1) Override all test functions.
- 2) Operate as described in the "Automatic Mode" section and shall continue to carry the emergency load; even if the switch remains in the "TEST" position or if the test switch is returned to the "AUTO" position.
- 5. The "TEST" position shall simulate a normal power failure and generator shall operate as described in the Automatic or Manual Mode section depending on the position of the Master Mode Switch. Loads will either be switched to the emergency source or remain unaffected, depending on the position of the respective NO LOAD TEST/TEST WITH LOAD switch. The function of that switch is described below.
- 6. The generator shall run continuously when the switch is in the "TEST" position.
- D. NO-LOAD TEST/ TEST WITH LOAD SWITCH:
  - 1. This two-position switch shall be functional only in the "TEST" Mode.
  - 2. In the "NO-LOAD TEST" position (transfer inhibit position) the system shall:
    - a. Start the generators and parallel themselves without paralleling to utility.
      - b. Log event in the PMC system, indicating that the TEST switch is in the NO LOAD TEST position.
  - 3. In the "TEST WITH LOAD" position (transfer allowed position) the system shall:
    - a. Start generators.
    - b. Once all generators comes up to correct voltage and frequency and are paralleled, the utility and the GEN tie breaker shall close using the user selected open or closed transition mode.
    - c. Log event in the MVGPS system, indicating that the TEST switch is in the TEST WITH LOAD position.
    - d. If a normal power failure occurs while an automatic transfer switch is set to the "NO-LOAD TEST" or the "TEST WITH LOAD" position, the power outage shall have priority over the test and the system shall;
      - 1) Immediately assume control over all loads and operate as described in "Automatic Mode" above.
- E. SAFETY INTERLOCKS
  - 1. All safety interlocks and monitors shall function in the Test Mode, the Automatic Mode, the Offline Mode, the Manual Mode and failure scenarios.
  - 2. No source circuit breaker shall be able to be closed manually or automatically to the bus unless they are in synch with the bus or the bus is de-energized.
  - 3. Provide non-defeating type covers over the manual closing button on the breaker for all electrically operated circuit breakers. The breakers shall only be able to be closed via the MVGPS or manual pistol grip switches to ensure that the electrical interlocks are not defeated.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

A. Acceptable Products: Switchgear specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following

specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:

- 1. Eaton Cutler-Hammer.
- 2. Russelectric
- 3. Square D; ASCO Basis of Design
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.
- C. The above manufacturers are approved but their proposed products must fit within the noted width and depth of the space shown on the floor plans in the drawings. Do not submit equipment that does not fit these space requirements.

#### 2.2 GENERAL

- A. This section defines the general requirements for the products. See Appendices for specific project-based product rating requirements. Other appendices may be provided with sketches and schematics clarifying the requirements. The appendices and drawings are an integral part to this specification and shall be considered as such.
- B. The following information is typically depicted on the Drawings: bus configuration, bus ratings, interrupting ratings, component size and type, power line and feeder connections, application specific control wiring, elevation and footprint, etc. Where not shown on or able to be derived from the Drawings, the minimum requirements specified herein shall be provided.
- C. Switchgear rated voltage shall be 4160VAC, 3-Phase, 3-Wire operating at a frequency of 60 Hz.
- D. The system ampacity is determined by the total combined load distribution of the feeder breakers. System ampacity shall be as noted on Drawings. All horizontal bus shall be rated to the full ampacity of the system. Tapered bus is not acceptable.
- E. The short circuit current rating of the system shall be determined by the available fault current at the Low Voltage Switchgear as indicated on the Drawings. All circuit interruption shall be accomplished by the circuit breaker and without the aid of limiter fuses. The Short time rating shall also be a function on the desired selectivity of the electrical system. Short Circuit and Short Time ratings shall be specified on the drawings.
- F. Equipment shall be suitable for use as service entrance equipment and labeled according to UL requirements.

# 2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Entire system, including but not limited to busing, circuit breakers, enclosure, controls, accessories, internal and external supports for components, supports, wiring, and piping shall be designed to withstand effects of earthquake motions, i.e. static or anticipated seismic forces, or both, in any direction, as determined according to ASCE/SEI 7. The designated equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.

- B. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- C. Use increased importance factor of 1.5.

#### 2.4 INSTRUMENT TRANSFORMERS:

- A. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 1. Provide current transformers as required.
  - 2. Furnish shorting blocks for all CT secondary circuits.
  - 3. Comply with IEEE C57.13, NEMA EI 21.1
- B. Potential Transformers: Provide 3-Phase PT with fused primary and secondary leads, where required, to limit voltage leads into control devices to 120V and to allow sych-check functionality between main buses.
  - 1. Provide separate PT's for each of the three phases, i.e. do not use open-delta configuration.
  - 2. Provide PT's wherever required to allow the relays and meters to function properly. Not all PT's are shown on the construction documents.

#### 2.5 CONTROL POWER

- A. Control voltage shall be from a combination of redundant 125VDC station battery sources and 24VDC sources from each generator's redundant starting batteries and oversized 35A battery chargers. Redundancy shall be maintained as far downstream as possible.
- B. Provide best battery selector diode device for DC power sources.
- C. Any 120VAC control power needed shall be obtained from two external 120VAC branch circuits via a control power transfer relay (83 device). It shall be self-powered and configured to draw control power from the preferred source, automatically transfer to the other alternate source, and re-transfer automatically when the preferred source is restored. The control power transfer relay shall be capable of transfer between two power sources that may not be in phase.
- D. Loss of any control power source shall be annunciated on the HMI, including power that is downstream of DC/DC or AC/DC converters or from other power supplies.
- E. Control-Power Fuses: Each control power input sources and output circuit shall be separately protected with fuses for current-limiting and overload protection. Control power to each MV breaker shall be separately fused to prevent a single fuse failure from disabling the system.
- F. Provide separate control power circuits for: (AC and DC as required)
  - 1. Each generator paralleling PLC
  - 2. Each main PLC and backup
  - 3. HMI
  - 4. Each electrically operated breaker's Close and trip coils
  - 5. Each electrically operated breaker's spring charging coil.
  - 6. Provide minimum 50% oversized power supplies if needed in addition to the generator starting batteries for obtaining 24VDC control power.

# 2.6 SWITCHGEAR CONSTRUCTION:

- A. General: Provide freestanding, dead front, dead rear, floor mounted, indoor type, switchgear.
- B. Switchgear framework.
  - 1. Fabricated on a die-formed steel base or base assembly, welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. Corners shall be reinforced with rugged gussets. The sections shall be completely metal enclosed.
  - 2. Designed to withstand the mechanical stresses caused by rough handling during shipment, in addition to the electrical and mechanical stresses which occur during the operation of the assemblies and during a fault condition.
  - 3. Framework formed of code gauge steel (12 gauge minimum) suitable for use as floor sills in indoor installations. Provide mounting hardware suitable for installation in the project site seismic zone category.
  - 4. Each switchgear section shall have open bottom, as required, for ready installation and termination of conduits. Top and bottom conduit and bus duct entry area is to be clearly shown and dimensioned on the shop drawings.
  - 5. All side and top panels shall be removable, attached by captive bolts, and small enough for easy handling by one person. All panels shall be fabricated from minimum 12 gage steel and shall have die formed edges all around.
  - 6. Distribution sections shall be designed to permit future additions of distribution breakers without disturbing the initial installation.
- C. Doors and Access Panels:
  - 1. All front and rear panels are considered to be hinged doors.
  - 2. Doors and access panels shall be constructed of 12 gauge (min.) formed steel. Hinges shall allow the doors to swing through not less than 105 degrees from the closed position. Provide louvers or vents, where required, to give adequate ventilation.
  - 3. All front and rear panels/doors shall be removable via its hinge pins and shall be provided with locking, rotary latch type padlockable handles for easy access. Do not use bolts, use handles only. Door locks shall be keyed alike and allow the keys to be removed in the locked and unlocked position.
  - 4. Individual front doors with latch type operating handles, shall be supplied for each draw-out circuit breaker compartment. Layout shall be reviewed when shop drawings are submitted for review.
  - 5. Quality and quantity of the door hinges and latches shall be such that they can withstand the mechanical stresses due to a fault condition, i.e. equal to the strength of the closure that would have been provided by if the panel were bolted.
  - 6. Doors shall not sag when all options are installed.
  - 7. A print pocket, located on the inside face of the door shall be provided.
- D. Barriers/ Isolation
  - 1. All sections shall be completely enclosed within grounded metal enclosures.
  - 2. Secondary control devices and their wiring shall be isolated by grounded metal barriers from all 480V primary devices.
  - 3. Major components of the primary circuits, such as circuit breakers, transformers and bus, shall be isolated by grounded metal barriers.
  - 4. Between adjacent switchgear sections.

- 5. Isolation for main bus of main section and main and vertical buses of feeder sections.
- 6. Draw-out circuit breakers shall be installed in individual front compartments with separate doors.
- 7. Buses shall be installed in rear compartments.
- 8. If a rear compartment is utilized to house any control components, grounded metal personnel protection barriers shall be provided to isolate the bus compartments.
- 9. Main generator cables and load cables shall be capable of entering the bottom of the cubicle to high compression type connection lugs on the breaker or bus without passing through any other cubicle compartment except the bus compartment.
- 10. Bus-Bar Insulation: Factory-applied, flame-retardant, insulation. Minimum insulation temperature rating of 105 deg C.
- E. Dimension:
  - 1. The switchgear shall be the depth shown to house all equipment contained within it. The enclosure shall be constructed so that there is back and front access. Construction of the board shall allow maintenance of incoming line terminations, device connections and all bus bolted connections.
  - 2. Conform to the arrangements and details, as shown on the drawings, and to the space designated for installation.
  - 3. Construct so highest operating handles do not exceed 6'-6" above floor.
- F. Provide adequate gutter space in all sides of switchgear sections. Arrange for clearance to permit good accessibility of feeder conductors into switchgear.
- G. Die-pierce holes for connecting adjacent sections to assure alignment and facilitate future additions.
- H. Bolts, nuts and washers shall be cadmium plated, rustproof metal. Any bolts securing removable panels shall be of the captive-type design.
- I. Suitable means shall be provided near top and bottom of switchgear to insure adequate ventilation for all equipment within the switchgear assembly.
- J. Front- and Rear-Accessible Switchgear:
  - 1. All Breakers and Power Devices: Drawout mounted, per single-line diagram.
  - 2. Sections front and rear aligned.
- K. Main-Bus Continuous Rating: Per single-line diagram
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

# 2.7 NETWORK, NETWORK INTERFACES AND SECURITY

- A. The Owner's Ethernet-based Network will be used to facilitate remote monitoring only for the MVGPS. All other communication, including systems being integrated by the Supplier such as MV Switchgear, Diesel-Engine-Driven Generator sets and others shall be stand-alone and dedicated for this equipment only. The supplier may choose to retain two dedicated, LAN-A & LAN-B, networks for their PLC controls. Inputs from devices such as CAT EMCP controllers, SCR Controllers, SEL relays, etc. shall be obtained via Ethernet over a dedicated network.
- B. System IP Addresses and VLANs

- 1. The Supplier shall provide all required IP addresses to be used by the Suppliers.
- 2. The Owner will supply a single Ethernet connection for remote monitoring of the entire system.
- 3. The Supplier shall implement the assigned IP address and VLAN for the devices supplied and integrated into the MVGPS.
- C. Allowed Communication Protocols
  - 1. Ethernet
    - a. IEC 61850
    - b. Modbus TCP/IP
    - 2. Non-Ethernet Communication to Remote Input / Output Modules and Devices
      - a. The preference is to avoid non-Ethernet communication, where possible
      - b. Modbus RTU over RS485 for up to 32 devices per communications string may be allowed upon Owner's approval.
- D. Cable Requirements
  - 1. Ethernet
    - a. Copper: The Supplier shall provide Category 6 Shielded Twisted Pair (STP) copper cables to connect to port on each device.
    - b. Fiber Optic: If specific devices allow only for fiber-optic connections the preferred cables are Single Mode Fiber, 1310 band. Supplier to provide matching cable and fiber-optic transceivers as required.
  - 2. RS485: Each string shall consist of an approved 22 AWG (or greater) twisted pair shielded cable for RS485 communications.
- E. System Time Reference (STR) and Time Synchronization
  - 1. Network Time Protocol (NTP) synchronization signal shall be utilized by all power meters, protective relays, trip units, PLCs, PLC timestamp modules.
- F. Intelligent Device Configuration and Security
  - 1. Software and devices shall be configured by the Supplier using information security best practices.
  - 2. Assign IP address, subnet mask, gateway based on range provided by the Owner.
  - 3. The username and password must be changed from factory default to a complex and unique. The factory default accounts and passwords must be removed.
  - 4. If access to the device is available through a web browser on the network. It is required to use HTTPS (port 443) and disable HTTP (port 80) access.
  - 5. Configure Date and Time settings using NTP server IP address.
  - 6. Assign the device a meaningful name using Owner's naming convention (do not use the factory default).
  - 7. Assign the device a meaningful location (if field is available).
  - 8. Verify that the device is running the latest compatible firmware version and perform upgrade if a newer version existing.
  - 9. Disable all unused ports and protocols including telnet.
  - 10. Enable SSH (if available).

# 2.8 BUSING AND CABLE COMPARTMENT

- A. All bus joints shall consist of SAE Grade 5 hardware and conical spring (e.g. Belleville) washers to withstand mechanical forces exerted during short circuits. All primary bus joints shall consist of a minimum of 2 bolts.
- B. Busing shall be insulated tin plated copper along its entire length.

- C. Busing shall be braced to withstand the instantaneous interrupting rating of the main breaker(s) or 40kA minimum (RMS symmetrical)
- D. A copper ground bus (minimum 1/4 x 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear.

#### 2.9 HORN SILENCING

- A. Provide horn silencing pushbutton.
- B. After silencing, alarm shall sound again automatically if another alarm condition develops. On/off switch is not acceptable. Alarm lights shall remain lighted until fault condition is corrected and the system is reset.

#### 2.10 MISCELLANEOUS REQUIREMENTS AND EXTRA MATERIALS

- A. Provide to the owner all special tools and testing devices required for routine maintenance, switchgear test, inspection, maintenance, and operation.
- B. Remote Safety Devices:
  - Remote Racking: Vacuum circuit breakers to be designed to be safely racked-out from the connected position, and racked-in to the connected position in the circuit breaker compartment using an electrically operated remote racking device. The Electric Racking Device (120 VAC) shall include a 50 foot long cord and a hand held operator. A crutch shall be provided to avoid damage to the racking mechanism.
  - 2. Provide remote Breaker Open/Close device to operate breaker's pistol grip.
- C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- D. Fuses: Six of each type and rating used. Include spares for potential transformers, control power circuits and fusible devices. Provide index on the inside cover listing where each fuse can be used.
- E. Indicating Lights: Six of each type installed.
- F. Touchup Paint: [2] containers of paint matching enclosure finish, each 0.5 pint.
- G. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- H. Provide a complete spare parts list, including recommended quantities and prices.
- I. All locks and key switches shall have identical keying to operate from a single key.
- J. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

#### 2.11 IDENTIFICATION AND MIMIC BUS

- A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchgear. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
- B. Coordinate mimic-bus segments with devices in switchgear sections to which they are applied. Produce a concise visual presentation of principal switchgear components and connections.

- C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- D. Externally visible, permanent nameplates shall be provide to identify each instrument, instrument switch, meter, protective relay, control switch, indicating light, circuit breaker compartment. Relays shall be designated as to use, and as to the phase to which they are connected.
- E. Nameplate inscriptions shall be submitted and will be reviewed and determined when shop drawings are submitted for review. All nameplates to be color coded for each switchgear end. A-side is blue background with white letters; B-side is red background with white letters.
- F. Nameplates shall be provided per details in the construction drawings. Provide nameplates for each section of the switchgear.
- G. Internal switchgear components shall be installed on mounting pans with all components identified by tag indications located above or below the specific component. Identification shall use full english words, such as "CPT Primary Fuse" in addition to the abbreviations used in the shop drawings.

#### 2.12 INSTRUMENT AND CONTROL WIRING AND TERMINATIONS

- A. Instrument and control wiring shall be of flame retardant, 600-volt, type "SIS", #14 AWG minimum size, stranded copper, approved for switchgear use. Shielded cable shall be used on all low level circuits where required and shall be #18 AWG minimum. Wiring shall be installed in wire troughs with removable covers. Exposed wiring shall be kept to a minimum.
- B. All wiring to equipment and devices mounted on hinged doors, and/or panels, shall be extra flexible copper, stranded type.
- C. All wire terminations shall be made at terminal blocks, meters, relays, and other similar devices, and shall be made with ring tongue or spade type crimp type lugs. There shall be no splices in the wiring.
- D. Interpanel terminal blocks shall be used for interconnecting the wiring between panels at shipping splits. All wiring between shipping sections shall be installed by the manufacturer's field technician. Wiring between shipping splits may be terminated by the Contractor, but they remain the responsibility of the manufacturer. Wiring shall be disconnected at one end, for shipping. Both the free end and the intended location on the terminal strips shall be labeled with the same identification to minimize errors in the field connections.
- E. Suitable provisions shall be made for training and supporting incoming cables from the point of entrance to the termination on terminal blocks.
- F. Each internal interconnecting wire shall be identified by means of a permanent identification marker labeled with a unique wire number and destination/origination markings. Wire markers shall be heat-shrink sleeve type or as approved thru shop drawing review and located at each end of the wire. Wire numbers shall match the manufacturer's interconnection drawing.
- G. Terminal blocks shall be supplied and clearly marked for wiring which will be installed or reconnected by the Contractor, including wiring between shipping sections.

- H. Terminal blocks shall be equipped with screw type terminals for accommodating ring tongue or spade wire terminators.
- I. All terminal blocks to be numbered and terminal block points shall be identified with permanent identification markers to match those shown on the wiring diagrams.
- J. The switchgear manufacturer shall provide a minimum of 5% spare terminal connections.

#### 2.13 GENERATOR GOVERNOR:

- A. Speed control and prime mover load sharing shall be automatic and inherent functions of the governor components. The control system shall be designed for operation with engine generator having speed control, load sharing, electronic type isochronous governors. The electronic control and speed adjustment devices shall be wired to the engine/generator control panel by the switchgear manufacturer. The governor actuators shall be supplied by the engine generator supplier and located on the engine.
- B. The controller shall be equal to the latest model of SEL 700G or approved equivalent.

#### 2.14 GENERATOR VOLTAGE REGULATOR

- A. Voltage regulation shall be a function of the automatic voltage regulator for generator and shall be supplied by the generator supplier to ensure they are compatible with the generator excitation system. The voltage regulators shall be as specified in MV Diesel Generator Section.
- B. Voltage regulators shall be able to be controlled by the PLC for dynamic paralleling.
- C. The voltage regulators shall be latest solid-state model.

# 2.15 SEQUENCE OF OPERATION

- A. MVGPS vendor to provide complete, detailed written Sequence of Operation (SOO) matrix, for Engineer of Record review and approval, for all normal, test, maintenance and failure modes.
- B. Basic SOO Modify and add as required to provide a reliable and flexible system:
  - 1. The basic intent is to have each half of the switchgear served from its own Utility service.
  - 2. In the event of loss of one utility service and the total load is LESS than the remaining utility service then it shall supply all the loads.
  - 3. In the event of loss of one utility service and the total load is MORE than the remaining utility service then the remaining utility service shall continue to supply its loads and the generator system shall be started to serve the other side.
  - 4. In the event of loss of both utility services, the generator system shall be started to serve both sides.
  - 5. If there are more generators online than needed capacity, based on user adjustable headroom and capacity setpoints then the system shall load demand down as possible.
  - 6. If output breakers serving one side of the MVDS switchgear fails, then the entire load can be handled by closing tie breaker on MVDS switchgear.
  - 7. Allow for testing of the generator system with and without switching building loads.
  - 8. Allow for testing of the generator system with a portable load bank connected. It will require a temporary step-down transformer.

9. Allow for manual planned maintenance of any side of either switchgear by the use of soft pushbuttons and automated configuration of output main & tie breakers.

# 2.16 LOAD SHED SYSTEM

- A. Load Shed System: The automatic load shed system shall operate as a part of the master MVGPS. It shall concurrently on a real time basis monitor the load condition of the bus and each MV output breaker via its SEL relay. It shall be programmed to monitor total source supply capacity connected to each load bus and compare it to the connected load. This scheme shall also monitor if the load on the bus exceeds an adjustable set point such as 85% or 90% of total source supply capacity.
- B. This system shall also incorporate automatic configuration of main and tie breakers to ensure the greatest number of loads are automatically added back upon loss of one or both utility sources and/or loss of generator sets.
- C. Provide graphic screen that shows for each output breaker:
  - 1. User adjustable Description of load
  - 2. Maximum average KVA (exclude momentary peak spikes), per a 8-hour sliding window. System shall automatically add back loads as it can based on these values while still maintaining the generator capacity head room noted above.
  - 3. User adjustable priority level Lower number is higher priority, i.e. to not be shed.
  - 4. User ability to manually shed and add loads when put into manual mode on this screen via password protected soft pushbutton.
- D. Provide control connection to each of the electrically operated output distribution feeder circuit breakers. Trip and close per sequence of operation.
- E. Provide controller expansion wiring/ programming for future expansion of additional load-sheddable breakers and (2) sets of dry contacts for remote loads.

# 2.17 CONTROL PANELS GENERAL

- A. Master Control Panel: Provide a PLC-based, control panel integrated into the MV switchgear assemblies. All constructed panels shall be compliant as an assembly to the location specific codes (USA UL listed).
- B. Master control section in the MVMGPS2 lineup shall oversee all operations of the complete paralleling system, including lineups MVDSA/MVDSB.
- C. System shall provide a Modbus TCP/IP output for customer use in a load shed/load add system. For each generator, Modbus output shall indicate "connected to bus" status and KW demand on that generator. In addition, system shall provide dry contacts signaling "Overload" status for use as needed.
- D. Panel shall include the following as a minimum:
  - 1. Two DC control power inputs with required DIN rail mounted converters, where converters required and best source transfer scheme, except for the remote panel which shall include an industrial UPS with 15 minutes minimum of support batteries. Batteries shall be monitored and remotely alarmed on failure.
  - 2. Redundant (2) DC Power Supplies. Each power supply shall have a metal casing with small-meshed ventilation grating so that screws, etc., cannot fall into the casing. The power supplies shall be sized as required plus 50 percent spare capacity, with a minimum output capacity of 240W.

- 3. Programmable Logic Controller (PLC):
  - a. Two fully redundant, hot backup, solid state, DC powered industrial programmable logic controllers (PLC) complete with chassis and sufficient dual I/O for system control and monitoring..
  - b. PLC systems shall have non-volatile memory.
  - c. PLC's shall have hot-backup synchronized redundancy. Configure so that backup PLC automatically assumes full system monitoring and control of the equipment if the primary PLC fails without any degradation of system performance or functionality. Configure either controller with the capability of operating as the primary or backup PLC.
  - d. Furnish PLC's with normally closed dry contacts that open upon PLC failure.
  - e. I/O Points requirements. Provide industry standard of care for points list and as noted herein.
  - f. Use of industrial grade contactors are preferred over ice cube relays for I/O, If the design uses Ice cube Relays they shall have gold plated contacts with a minimum 10um plating thickness for switching low currents. For higher currents Silver Nickel Alloy contact material is preferred.
- E. Manual Paralleling Controls:
  - 1. A Synchroscope with selector switch shall be located at the Master control cubicle. Selector switch shall allow for the selection of any generator for manual synchronizing and paralleling to the bus.
  - 2. Two voltmeters shall two frequency meters shall respectively indicate incoming source and the main bus.
  - 3. A solid-state synch-check relay shall be furnished for manual paralleling, to sense and compare the phase angle difference between the incoming generator and the bus. This relay shall lock out manual paralleling until the phase angle is less than 15 electrical degrees.
  - 4. Manual paralleling controls and synch-check relay shall be hard wired and shall not rely on touch screens or programmable controllers to perform manual paralleling functions.
- F. Generator Breaker And Control Section
  - 1. Each Generator section in MVMGPS2 shall include a single draw-out vacuum circuit breaker and all specified controls, including all required CT's and PT's for the operation of the specified protective relay. Stacking two generator circuit breakers in a single switchgear section will not be allowed.
  - 2. Each Generator section shall be provided with a protective relay similar to SEL 700G, with CT's and PT's integral to the Generator section.
  - 3. Each Generator section shall include a dedicated Generator PLC, similar to Modicon M340.
  - 4. Each Generator section shall include a discrete digital synchronizer and load controller similary to Woodward DSLC2.
  - 5. A DC-DC converter shall be included in each generator section to provide constant DC power, regardless of any fluctuation in incoming supply power.
- G. Enclosure:
  - 1. The enclosure shall conform to industrial grade NEMA 1 standards indoors.
  - 2. Mounting back panels shall be included for the interior to allow mounting of equipment and DIN-rail mounted devices as specified.
  - 3. Cooling fan with filter, where required

- 4. Locks: All doors shall be supplied with three-point handles and locks. The locks shall be keyed alike.
- 5. Lighting: The enclosure shall include a roof-mounted LED light assembly, activated by a door open switch. The light assembly shall be properly sized to fully illuminate the enclosure.
- 6. Control power transfer relay system that accommodates out-of-phase circuits.
- 7. Powder coat finish
- 8. Fully welded steel construction
- 9. Nameplates
- H. Identification: Refer to Division 26 Section "Identification for Electrical Systems." Identify panels, racks, devices, controls, and wiring.
- I. Wiring: All wiring shall be stranded copper and shall be a minimum of #16 AWG, 600-volt insulation. Power wiring shall be 600-volt, Type MTW, a minimum of #12 AWG as a minimum, sized as required by the NEC.
- J. Terminal Blocks: Terminal blocks shall be provided in each panel as required for the termination or continuation of wiring. Terminal blocks shall be two-layer IEC-style feedthrough models no more than 5-millimeters thick. The terminal blocks jumpers shall be of a design such that current-carrying parts are completely covered by insulating molding to ensure touch-safe, dead front operation. All terminal blocks shall be rated for 600 volts AC. The terminals shall be mounted on DIN rail with supports so that the rail is a minimum of 1-inch above the sub-panel to which it is mounted.
- K. Fuses: All fuses shall be sized as required for the circuit they are protecting. Fuses shall be installed in a combination fused disconnect/feed-through terminal of similar type and manufacturer to the Terminal Blocks (above).
- 2.18 PLCS APPLICATION SOFTWARE
  - A. Provide PLC application software for a fully operating and functional system as outlined in the sequence of operations.
  - B. The Supplier shall develop a detailed SOO for review and approval and prior to development of the Application Software and implementing the SOO.
  - C. Account for all circuit breakers or system failure scenarios such as circuit breaker fail to open, close or trip, breaker racked out, etc.
  - D. Account for all possible failure scenarios.
  - E. Provide data validation and diagnostics subroutines that monitor and validate each signal, input, output and internal operation of the PLC and ancillary components.
- 2.19 HUMAN MACHINE INTERFACE
  - A. The supplier shall supply industrial quality integrated touchscreen display, minimum 24".
  - B. Loss of HMI shall not disable the MVGPS system, i.e. full control and paralleling shall still be possible.
  - C. The Supplier shall provide all the necessary application software for the local touchscreen displays.
  - D. Local and Remote HMI interfaces and features:
    - 1. The local HMI shall be integrated into the MV switchgear master section.

- 2. Provide a matching Remote panel that is a read-only remote HMI, which displays all data available at the Master HMI, but which does not have any control capabilities. The remote HMI will be mounted in the Owner's engineer's office.
- 3. The MVGPS Supplier will create and display all of the graphical interfaces and HMI for the MVGPS on the PLC and industrial touchscreen display.
- 4. Password protected.
- 5. Provide the following HMI screens:
  - a. Main Menu to access screens
  - b. Main Single Line Diagram: Full system interactive graphical one- line display of the complete standby engine generator power and transfer switchgear system including all engine generators, medium voltage metal enclosed switches, generator switchgear and transfer switchgear showing all system status, source status, circuit breaker status, switch status, and metering information. Bus, breaker switch and engine generator color shall change state based on status: green for de-energized, red for energized and yellow for tripped/locked out.
  - c. System Overview Status Screen:
    - 1) All Breaker Status
    - 2) All Switch Status
    - 3) All Engine Generator Status
    - 4) All System Controls Status
  - d. System Control Setup Screen:
    - 1) For each switchgear assembly: Manual, Auto/Manual, Auto/Auto (Status and Selection)
    - 2) Transfer Transition Mode: Open / Closed
    - 3) Voltage and Frequency Pickup Settings
    - 4) Transfer Time Delay Settings
    - 5) Utility hit counter with adjustable time window
    - 6) Source Control Transfers
    - 7) Transfer Initiate pushbutton
  - e. Load Shed Screen:
    - 1) Load Shed: On / Off
      - a) Each MV distribution breaker shall be considered a load shed/add point. Provide control interfaces for each breaker.
      - b) Provide (2) spare dry contacts for additional possible future load shedding. Close to add and open to shed.
    - 2) Load Shed Set Points and Delays
    - 3) Add Levels and Shed Levels
  - f. Load Demand
    - 1) Load Demand: On / Off
    - 2) Shutdown Sequence

- 3) Pickup and Dropout Set Points and Delays
- 4) Engine Generator Run / Shed Priority (manual and automatic)
- g. Individual Engine Generator Monitoring and Control Screens:
  - 1) Engine Monitoring
  - 2) Generator Metering
  - 3) Engine Generator Status
  - 4) Engine Generator Breaker Status
  - 5) Engine Generator Alarms
  - 6) Engine Generator Stop / Start Controls
  - 7) Engine Generator Breaker Open / Close Controls
  - 8) Miratech SCR/ DPF system minimal tabular data display of major parameters and alarms. Alarms shall be integrated into the overall alarm messaging system.
- h. Generator Switchgear Screen:
  - 1) Switchgear Metering
  - 2) Generator Feeder Breaker Status
  - 3) Generator Feeder Breaker Open / Close Controls
  - 4) Protective Relay Monitoring
- i. Distribution Switchgear Status and Control Screens:
  - 1) Switchgear Metering
  - 2) Switchgear Breaker Status
  - 3) Switchgear Breaker Open / Close Controls
  - 4) Protective Relay Monitoring
- j. Testing Status and Control Screens:
  - Load Bank Test via portable load bank connected to MV output breaker noted. Temporary load bank will require a step-down transformer.
  - 2) System Testing No Load
  - 3) System Testing FacilityLoad
  - 4) Exercising
- k. Alarm and Notification Screen: Displays all status change of state notifications, warnings, and alarms with time/stamping. Allows notifications to be sorted by type, and allows individual acknowledgement of alarms. Designated alarms shall be sent to the operator by email.
- I. Event recording screen: Provides record of alarms, pre-alarms, breaker change of state and other system events that are all date and time stamped.

- m. Service Screen: Displays maintenance, screen calibrations, and user administration information.
- n. Diagnostics and help screens

# 2.20 OWNER'S REMOTE MONITORING

A. The Supplier shall facilitate integration of the MVGPS into an internet based remote monitoring system to allow Owner to receive, via email and SMS, all alarm and status change messages, etc. Control of MVGPS will not be over the remote monitoring system, i.e. monitoring only. This system shall be fully protected against any cybersecurity issues and cannot interface to the PLC control system.

# 2.21 HARDWIRED CONTROLS

- A. Generator Paralleling Switchgear (MVSG) Master Control Panel (MCP):
  - 1. Selector switches and devices on the front cover of Master Control Panel:
    - a. Spring Return Control Switch to select Manual or Automatic operation on loss of Utility. (one per both utilities)
    - b. Spring Return Control Switch to select Manual or Auto for return to normal operation.
    - c. Engine Generator Control Switch: Hardwired directly to generator controller with four positions: RUN ONLINE, RUN, AUTO, and OFF (for each engine generator).
    - d. Feeder Breaker Control Switch: Three position spring return to center with momentary positions OPEN and CLOSE (for each feeder breaker and load bank breaker). Operable only when System Master Control Switch is in MANUAL position.
    - e. Generator Breaker Control Switch: Three position spring return to center with momentary positions OPEN and CLOSE. Operable only when System Master Control Switch is in MANUAL position.
    - f. Alarm Horn: Sounds on alarm condition.
    - g. Alarm Silence Pushbutton: Silences alarm horn, will re-energize on new alarm.
  - 2. Provide a back-lit LED annunciator with the following status/alarm points on front cover of Master Control Panel:
    - a. System Not-In-Auto (Red)
    - b. Engine generator Not-In-Auto (for each engine generator) (Red)
    - c. Engine generator failure (for each engine generator) (Red)
    - d. Generator breaker Closed (for each generator breaker) (Green)
    - e. Generator Bus Under Frequency (Red)
    - f. Generator Bus Over Frequency (Red)
    - g. Emergency Start Signal Received (Green)
    - h. System Test No Load (Green)
    - i. System Test With Load (Green)
    - j. System Test With Load Bank (Green)
    - k. Spare (Green)
    - I. Load Add Activated (Red)
    - m. Load Shed Activated (Red)
    - n. Generator Bus Overload (Red)
    - o. Load Bank Breaker Closed (Green)
    - p. Load Demand Activated (Green)
    - q. Main or Skid Fuel Tank Low Fuel Level/High (Red)

- r. Main or Skid Fuel Tank Leaking (Rupture) (Red)
- 3. Bus summing analog kilowatt meter, scaled from zero to the maximum of the kW based on the CT and PT ratios, 4.5" switchgear meter with 1% accuracy
- 4. Bus summing analog kiloVAR meter, scaled from zero to the maximum of the kiloVAR based on the CT and PT ratios, 4.5" switchgear meter with 1% accuracy
- 5. Bus summing analog amp meter, scaled from zero to the maximum primary current based on the CT ratio, 4.5" switchgear meter with 1% accuracy and separate switch
- 6. Bus analog power factor meter, scaled from 0.5 (lag) to 1 .0 to 0.5 (lead), 4.5" switchgear meter with 1% accuracy
- 7. Control Switches:
  - a. Single/ Dual Source selector, used for the distribution switchgear tie breaker and MVGPS output breakers. Normally the distribution system is split with open tie breaker, served from two utility/ Generator services.
  - b. Utility, Generator Output & Tie Breaker Control Switches: Three position spring return to center with momentary positions OPEN and CLOSE. Operable only when System Master Control Switch is in MANUAL position.
  - c. Generator Breaker Control Switch: Three position spring return to center with momentary positions OPEN and CLOSE (for each transfer switchgear). Operable only when System Master Control Switch is in MANUAL position.
  - d. Alarm Horn: Sounds on alarm condition.
  - e. Alarm Silence Pushbutton: Silences alarm horn, will re-energize on new alarm.
  - f. Red EPO pushbutton with Lift-up STI Bopper Stopper Cover per generator and one on master for shutdown of entire system.
- 8. Provide the following push-to-test LED status indicator lights on control section for each main circuit breaker:
  - a. Green Circuit breaker Open.
  - b. Red Circuit breaker Closed.
  - c. Amber Circuit breaker Locked Out
  - d. White Circuit breaker Withdrawn.
- 9. Provide (3) individually mounted red LED annunciator lights, one per each Generator online.
- 10. Provide a back-lite LED annunciator with the following status/alarm points on front cover of Master Control Panel:
  - a. System Not-In-Auto (Red)
  - b. Generator Bus Under Frequency (Red)
  - c. Generator Bus Over Frequency (Red)
  - d. Generator Main Breaker Closed (typical of two) (Green)
  - e. Utility Main Breaker Closed (typical of two) (Green)
  - f. Emergency Start Signal Received (Green)
  - g. System Test No Load (Green)
  - h. System Test With Load (Green)
  - i. System Test With Load Bank (Green)
  - j. Spare (Green)
  - k. Load Add Activated (Red)
  - I. Load Shed Activated (Red)
  - m. Generator Bus Overload (Red)
  - n. Load Bank Breaker Closed (Green)
  - o. Load Demand Activated (Green)

- 2.22 PARALLELING CONTROLS
  - A. Provide Woodward controllers for both manual synchronizing and for automatic paralleling.
  - B. Provide LS6/ Easygen combination or MSLC/ DSLC devices, one set per generator.
  - C. All controllers shall intergrate with SEL-700G relay for each generator breaker.
- 2.23 PROTECTIVE RELAYS
  - A. The switchgear manufacturer shall furnish and install the quantity, type and rating of protection relay(s) as indicated on the drawings and described hereafter in this specification.
  - B. Provide appropriate front-mounted, voltage and current test switches to allow testing of protective relays.
  - C. Protective Relaying shall be microprocessor, high reliability, as specified below.
  - D. MV Protective Relaying
    - 1. Each MV Circuit Breaker shall be provided with SEL 751 relay, except for the generator breakers, which shall be SEL-700G.
    - 2. Coordinate with protection studies and provide all SEL ".rdb" programming/ configuration files as required to interface with the MVPSG and as required by the utility company. This includes all SEL parameters and logic equations that are required for this system.
    - 3. Submit electronic and hard-copies of the configuration files.

#### 2.24 PROTECTION AND INTERLOCKING

- A. The Supplier shall develop the required hardwired interlocking and work with the MV Switchgear and MV Diesel-Engine-Driven Gensets Suppliers to design and implement the hardwired interlocks.
- B. The Supplier shall develop an interlocking scheme to allow for a coordinated transfer between utilities and generators. Only one paralleling at a time shall be allowed for each utility feeder. Use Adjustable 5-second delay between utilities.
- C. Paralleling Switchgear Electrical Interlocks:
  - 1. Critical start/stop and alarm/shutdown signals from the MV distribution switchgear to the MVGPS shall be hardwired connection.
  - 2. Closing and tripping signals from the engine to the MVGPS shall be hardwired connection.
  - 3. Provide hardwired interlocking between feeder and tie breaker and associated downstream distribution switchgear breakers such that utility and generator paralleling can only occur at the Utility Main and Tie-# breaker pairs.
  - 4. Provide hardwired synch-check interlocking between MVGPS Tie breaker and associated utility breaker such that closing is not possible if out of synch.
  - 5. Monitor breaker status of Main-A and Main-B in the distribution switchgear and initiate tie breaker "C" closing only if distribution Main-A or Main-B is open. Open the associated upstream Main output breaker as well.

# 2.25 CONTROL POWER AND AUXILIARY POWER

- A. Control Power. Each MVGPS cabinet shall accept two independent power supplies to serve control, protection and indication devices. The type of power shall be as specified in Appendix A.
  - 1. The Supplier shall provide load calculations for each cabinet to facilitate the sizing of 125VDC station batteries and feeder circuits.
  - 2. Coordinated fusible elements shall be provided to each tap-off connection to avoid tripping of upstream devices on a local fault. Where the power bus crosses a fire break, the bus shall be fused.
  - 3. For devices with a single power input, source selection device shall be used to maintain high power resiliency.
- B. Auxiliary Power. Each cabinet shall accept one power supply to serve non-essential lighting and auxiliary loads, as required or specified. The type of power shall be as specified in Appendix A. The Supplier shall provide load calculations for each assembly to facilitate the sizing of feeder circuits. Each local circuit shall be protected and coordinated to avoid tripping of upstream devices on a local fault. Connect to dedicated circuit, one per switchgear side, in panel GLA.

#### 2.26 LABELING

- A. Warning signs inside and outside unit shall be provided as may be appropriate for a non-utility-maintained switchgear. Rear panels shall be labeled to prohibit opening while Switchgear is energized.
- B. A nameplate shall be visible with the Switchgear's ratings, manufacture's name, catalog number, date of manufacture and serial number.
- C. Externally visible, permanent nameplates shall be provided to identify each Switchgear bus, meter, protective relay, control switch, indicating light, circuit breaker compartment, etc. Relays shall be designated as to use. Equipment and terminal blocks within the compartments shall also be suitably identified. Nameplates shall be supplied with inscriptions as per Drawings, and approved by the Owner.
- D. Nameplates shall be laminated plastic, 3/32-inch (2.5mm) thick, attached with bolts. Characters shall be black engraved on a white background. Master nameplates are to be 4-inches (100mm) high by 12-inches(300mm) long with black engraved lettering on a white plate background. Function nameplates shall be 2-inches (50mm) high by 6inches (150mm) long with black engraved lettering on a white plate background. (Other specification sections may supersede the requirements of this paragraph. Refer to the Owner at time of bid for alternate or additional identification requirements.)
- E. TRAFFOLYTE labels are to be provided to identify all the equipment and component parts. They shall be fitted at the front and rear of each compartment. They shall be engraved in black characters on a white background with characters of at least 10mm height and fixed with nonferrous screws. Outgoing transformer feeder sections shall also be labelled with the name of the transformer which it is feeding. A separate label with characters of at least 100mm high shall be fixed to the center of the switchgear to identify the switchgear by its equipment reference.

# 2.27 SOURCE QUALITY CONTROL

A. The Owner, and its representatives shall have the right to inspect all equipment covered by this Specification at any time and to witness any tests made on the

equipment. The Manufacturer shall notify the Owner in writing at least 10 working days prior to shipment to permit the Owner the option of inspecting the equipment at the factory.

- B. Factory Acceptance Tests
  - 1. General:
    - a. Test procedures shall be submitted to the Owner for review and approval.
    - b. Factory test results shall be submitted for review and approval.
    - c. The equipment shall not leave the factory until the factory tests are satisfactorily demonstrated and the system accepted.
  - 2. Unwitnessed tests. The Manufacturer shall verify proper operation of equipment and perform all required by code routine tests. As a minimum the following tests should be performed:
    - a. Controls validation tests to verify component functionality and sequence of operation.
    - b. Dielectric Test: Each assembly shall be subjected to a dielectric-strength test in accordance with the referenced standards.
    - c. Meter Accuracy Check: Meters shall be checked for accuracy and adjusted.
    - d. Functional Checks: All components, including breaker controls, interlocks, shall be tested to determine proper operation. All control functions, key interlocks and indicators shall be verified.
    - e. Communication Tests: Internal and inter assembly communication shall be tested and verified
    - f. Interface to Switchgear Tests: The Supplier shall liaise with the switchgear manufacture to demonstrate proper control interface signals are being sent to the switchgear components to implement the required control sequences.
    - g. Interface to Owner remote monitoring email/ SMS Tests: The Supplier shall ensure proper alarm & status information is transmitted.
- C. Factory Acceptance Tests:
  - 1. Level 1a Commissioning: MVGPS Factory Acceptance Test. The Supplier shall repeat the required factory tests including a complete simulated SOO test in the presence of the Owner or/and an authorized representative.
  - 2. Level 1b Commissioning: Integrated Switchgear-MVGPS Factory Acceptance Test. The Supplier shall liaise with the MV Switchgear vendor to set up and perform an integrated test in the Switchgear Supplier's facility. Integration and operation of the two systems as a whole shall be demonstrated, including, but not limited to: metering integration; protection system operation and integration; breaker and controls integration and operation; sequence of operation testing; maintenance isolation and operation, and others. MVGPS Supplier shall ship control assemblies to Switchgear for integration to switchgear for FAT 1b. MVGPS Supplier shall design and support temporary wiring between MVGPS and switchgear marshalling cabinets.
  - 3. The Owner reserves the right to omit some or all of the Level 1a tests. Levels 1a and 1b tests may be executed in a sequence to minimize travel for the Owner, Engineer, Contractor and Cx Agent.

# PART 3 - EXECUTION

#### 3.1 EXAMINATION AND PREPARATION

- A. The Contractor shall verify dimensions, tolerances and method of attachment with other work.
- B. The Contractor shall verify that openings, conduit stub-ups and overhead works align with the equipment to be installed in place.
- C. The Contractor shall verify that anchoring devices have been properly installed and located.
- D. Installation work can only proceed if the installation location is examined and prepared to receive the equipment. Notify Owner and its representatives, if area preparation does not conform to the installation requirements and tolerances.

#### 3.2 CLEANING AND PROTECTION

- A. After receipt of equipment and prior to acceptance, the Contractor shall keep the installed products clean and shall provide adequate equipment protection throughout the project.
- B. At no time shall personnel be allowed to sit or stand on equipment enclosures or use them as support for working above. Internal components, electronics, coils and windings, shall be kept clear of dust, filings and other construction debris.
- C. Temporary Heating: Apply temporary heat to the equipment, according to manufacturer's written recommendations, throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.
- D. Cleaning: Inspect interior and exterior of installed equipment. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish. Periodic cleaning shall be performed where required. The equipment shall be given a thorough cleaning prior energization and prior to turn-over.
- E. Any damage to the equipment prior to turn-over shall be corrected to original condition and to the Owner's satisfaction at the Contractor's cost.

#### 3.3 INSTALLATION

- A. The Supplier shall provide installation instructions and assist the Contractor with the interpretation of the instructions and provide installation clarifications as required.
- B. The Contractor shall perform all the work necessary for a functionally complete installation, including openings in structures, holes, penetrations, bases, plinths, support steelwork, containments, bunds etc. All rigging required for unloading and installation shall be the responsibility of the Contractor.
- C. The Contractor shall provide all associated external materials for control power connections and low voltage control wiring.
- D. Equipment Mounting:
  - 1. The equipment shall be installed following the procedures set forth by the Supplier. The Supplier shall assist the Contractor as required in interpreting the installation instructions. The Contractor shall certify to the Supplier and the

Engineer that the installation has been performed per the Supplier's latest documents and instructions.

- 2. Concrete equipment pads shall be provided where shown on the Drawings. The pads shall extend between 1 and 2 inches beyond the dimensions of the equipment base structure, with additional extension where auxiliary transformers are located. Pad height shall be coordinated with the breaker removal requirements (e.g. breaker extraction trolley) and the surrounding grade. The pads shall incorporate leveling steel channels that are suitable for welding to switchgear bottom channels for anchoring purposes.
- 3. The Contractor shall solidly anchor all equipment to the equipment pads. Embedded anchor bolts or bottom rail welding shall be provided by the Contractor and approved by the Manufacturer. No anchoring devices shall be installed outside the overall dimensions of the equipment.
- 4. All penetration through walls, partition etc., shall be fully sealed without compromising the air integrity of the spaces. In addition, all fixtures and electrical accessories, electrical devices, and detectors shall not compromise the air integrity of the spaces.
- E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and applicable codes and standards.
- F. The Contractor shall refer to the appropriate construction specifications and drawings for the installation requirements for conduits, wire, terminations, boxes and testing. Connect equipment ground buses to common building ground system. Tighten bus joint, connector, and terminal bolts according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in codes and standards (USA: UL 486A and UL 486B).
- G. Connections:
  - 1. Interconnect system components. Make connections according to wiring diagrams unless otherwise indicated. The Cabling installation shall be carried out as per the Project Specific Electrical Specifications.
  - 2. The Contractor shall provide all termination lugs, wire ferrules and cable termination kits required to make up terminations.
- H. Grounding
  - 1. Provide safety grounding for cabinets and doors
  - 2. Terminate control wire shields following the Supplier's instructions, preferably on one side only
- I. Identification. Identify components and wiring according to the project specific Identification for Electrical Systems requirements.
- J. Safety Requirements. The Contractor shall carry out the necessary risk assessment relating to working with electrical equipment. In addition to the standard PPE required (protective helmets, eye protection, gloves, protective shoes, high visibility vest, etc.), as a minimum arch flash protection, insulating rubber gloves, leather protective gloves shall be used for the application.

# 3.4 MANUFACTURER'S FIELD SERVICE

A. Maintain a local competent manufacturer's service organization, capable of providing quality service and replacement parts. Availability and response times and additional service requirements shall be as specified in other sections.

- B. The Manufacturer shall attend a schedule coordination meeting at the site prior to start of construction for the purpose of integrating installation schedule of other Suppliers and the Contractor.
- C. Qualified manufacturer's field representatives shall be on-site at the start of construction to observe installation of switchgear assemblies, inspect, test, adjust components and assemblies and facilitate on-site support from installation through various levels of Commissioning activities. Site testing may require weekend or overtime work. Based on qualifications and performance, the Owner or the Owner's representatives, may direct the Supplier to replace the field representatives.
- D. During startup and if repair required, field service must be unlimited and must continue until satisfactory system operation and Engineer's approval has been achieved.
- E. The time for on-site support through construction and commissioning period shall be indicated in the scope of work and base bid price.

# 3.5 FIELD QUALITY CONTROL

- A. The Contractor shall execute quality control and testing activities related to the equipment specified herein in accordance with specifications "01 45 16.13 Contractor Quality Control", "01 45 29 Testing Agency Services" and "26 05 93 Electrical Equipment Testing Requirements. Additional testing and commissioning requirements are also defined herein.
- B. Non-conformance
  - 1. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner.
  - 2. The Owner and its Representatives reserve the right of rejection at the job site if the above conditions are discovered even after acceptance at the factory.

# 3.6 SITE START-UP, TESTING & COMMISSIONING

- A. General Requirements
  - 1. The Supplier shall provide storage requirements, installation and startup checklists to the Owner and General Contractor for their review and acceptance, prior to commencing Level 2 Commissioning.
  - 2. The MVGPS, Generator and Switchgear Suppliers shall jointly review and comment on Level 4 testing scripts provided by the Commissioning Agent.
  - 3. The Supplier shall provide the necessary equipment, consumables (including air filters), labor, accessories, test instruments, meters, freight and shipping costs, transportation and subsistence costs necessary to accomplish the vendor startup as it relates to the switchgear assemblies specified herein. All test equipment shall be laboratory calibrated and certified.
  - 4. The Supplier shall provide the services of an adequate number of personnel including manufacturer's factory- trained representatives to start up and commission the MVGPS, then to operate the systems during the site acceptance tests and to check all details of the installation. Include, at no additional cost to the Owner, the services of these personnel and representatives for the duration of the testing. Include all overtime, off-hour, weekend, or holiday work necessary for the site acceptance testing at no additional cost to the owner.
  - 5. The Contractor shall provide electrical trade labor for site tests.

- 6. The CxA shall submit test procedures for commissioning. Test procedure shall be reviewed by the Engineer and Manufacturer.
- 7. The Supplier shall coordinate with the Contractor, Engineer and Owner all testing times and dates.
- 8. Perform all tests without adjusting the system during the test. Failure of any component or system will require the components to be replaced or repaired and all associated tests repeated.
- 9. The site acceptance tests must be conducted in the presence of the Owner and the CxA .
- B. Equipment Storage, Delivery, and Installation (Level 2 Commissioning)
  - 1. Upon delivery, inspect equipment for:
    - a. Equipment shipped matches the equipment tested during Level 1 FAT
    - b. There are no alterations to the equipment after Level 1 FAT
    - c. There is no damage to the equipment from transportation
    - d. Equipment that was tested in the factory as a group shall be installed as a group.
    - e. Confirm the tilt, shock and vibration devices show no abnormal shocks or tilts during transit.
  - 2. After installation, check and verify:
    - a. Equipment installed in accordance with the Manufacturer's requirements Complete installation and startup checks according to manufacturer's written instructions.
    - b. Equipment installed in accordance with drawings, plans and specifications
    - c. Installation is compliant with local codes and standards and health and safety requirements.
    - d. Equipment is accessible for operation and maintenance
    - e. Perform visual and mechanical inspections on the complete switchgear installation including individual cubicles, input and output connections, and all other associated equipment and components.
    - f. Verify that electrical wiring installation complies with manufacturer's submittal and with written installation requirements in other electrical Sections.
- C. Supplier Startup (Level 3 Commissioning)
  - 1. Develop and update check lists and scripts for Level 3 Testing
  - 2. Verify interface connections.
  - 3. Set field-adjustable settings in accordance with Engineer approved parameters.
  - 4. Power up and verify operation of each component.
  - 5. Verify that all components, status lights, alarm lights, audible alarms, meters, and other operational devices are functioning properly.
  - 6. Functional check of all power train components, under load and for all modes of operation, to determine proper operation.
  - 7. Simulate malfunctions and failures to verify the proper operation of control system. Indicate on test form which devices were tested, how they were simulated, and the resulting operation of the system. Record all results.
  - 8. Verify all inhibit functions and indicators.
  - 9. Verify operation of hardwired and Ethernet interfaces. Confirm proper communication and readings at local HMI and interfaces to SCADA/ENMS/EPMS. Provide alarm logs confirming trip points tested.
- D. Functional System Testing (Level 4 Commissioning)

- 1. Supplier shall provide support to CxA for Level 4 commissioning.
- 2. CxA to provide list of indications, parameter values, and system responses considered satisfactory for each test action. Included will be tabulation of actual observations during test
- E. Level 5 Integrated System Testing (IST)
  - 1. Following the completion of all system and component testing and before applying critical load to the system an overall Integrated System Test (IST) will be conducted on the complete critical electrical distribution system.
  - 2. Upon completion of the Level 4 acceptance tests, the Manufacturer shall be available to support an Integrated Systems Test (IST) in which the switchgear will be tested as an integral part of the overall facility, to verify compatibility with the other mechanical and electrical systems. The participation shall include:
    - a. Review and approval of integration test procedures produced by the Engineer or Commissioning Agent, and assurance to the Owner that such tests will not be destructive or void warranties.
    - b. Attendance at test scheduling meetings, or provision of information as required by the Contractor to properly schedule the Vendor's activities through the testing period.

# 3.7 FIELD TEST REPORTS

- A. The Manufacturer, Supplier and independent testing agencies shall supply their certified test reports and data for each of the factory and site tests conducted by them as specified herein.
  - 1. Test Reports
    - a. All test data shall be recorded and certified by the Manufacturer or testing agency conducting the aforementioned tests. Any defects noted during the tests performed shall be brought to the attention of the Engineer for corrective action. Submit electronic and three (3) hard copies and soft copies (.pdf format) of all test reports for approval and/or corrective actions.
    - b. Each test report set submitted shall be clearly identified by the Purchaser's name, the project name, the purchase order numbers, the equipment description and specific identification, and the manufacturer's name and address. Each individual document shall be legible and shall have reproducible capability.

# 3.8 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the switchgear and associated equipment.
- B. For the initial installation of a new Manufacturer, provide an Add price for Training in the Bid.
  - 1. Engage a qualified trade or manufacturer's representative to provide the instructions on each major piece of equipment. This trainer may be the start-up technician for the piece of equipment, the installing contractor, or a manufacturer's representative. Trainers shall be factory-trained and authorized. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. Specifically, the trainer must have site specific knowledge as well as general knowledge of the system. More than one party may be required to execute the training.

- 2. Start training with classroom sessions followed by hands-on training on each piece of equipment.
- 3. Classroom training shall use slides, drawings, and O&M manuals to cover as a minimum:
  - a. Purpose and function of the equipment
  - b. A brief working knowledge of the operating theory of the equipment
  - c. Submittal drawings, catalog data, and O&M manual content and organization
  - d. Available parts lists, including recommendations regarding parts that should be readily available and stored on site
  - e. Local representatives for service, parts, and repair, including contact information
  - f. Startup, shutdown, normal operation, and emergency operating procedures
  - g. Safety and emergency procedures including proper precautions when around equipment
  - h. Daily, weekly, monthly, quarterly, semiannual and annual routine preventative maintenance requirements and procedures
  - i. Required equipment exercise procedures and intervals
  - j. Normal and major repair procedures
  - k. Equipment inspection and troubleshooting procedures including the use of applicable test instruments
  - I. Routine and long-term calibration procedures
  - m. Identify location of all related equipment power disconnect switches, fuses and circuit breakers
- 4. Site Demonstrate is required for the following:
  - a. Equipment exercise procedures
  - b. Demonstrate and perform standard operating procedures and checks
  - c. Demonstrate routine preventative maintenance activities including mechanical and electrical adjustments and calibration
  - d. Demonstrate routine disassembly and assembly of equipment if applicable
  - e. Identify and review safety items and perform safety procedures
  - f. Hands-on training shall be on-site and use O&M manuals as a guide to cover as a minimum:
  - g. Equipment section functions
  - h. Site and equipment specific interlocks and control functions
  - i. Instrumentation and controls, and interpretation of displayed information
  - j. Demonstrate startup and shutdown procedures
- 5. Identify location of all related equipment power disconnect switches, fuses and circuit breakers
  - a. Demonstrate required equipment exercise procedures
  - b. Demonstrate and perform standard operating procedures and checks
  - c. Demonstrate routine preventative maintenance activities that are part of the DCOPs maintenance scope.
  - d. Demonstrate routine disassembly and assembly of equipment if applicable
  - e. Identify and review safety items and perform safety procedures
- C. Training Duration and Schedule
  - 1. Minimum for initial training shall be 40 hours, but the period shall be longer if required to complete the training tasks described herein.
  - 2. Training sessions shall be scheduled with classroom sessions interspersed with hands-on field instruction in logical sequence.

- D. Training Plan Submittals & Timing
  - 1. Develop a preliminary training plan outline and schedule of training dates and submit to the Owner's Representative for review and approval a minimum of 60 days before the planned training sessions.
  - 2. Once the training plan outline is approved, submit one complete set of lesson plans, training manuals, handouts, visual aids and reference material organized in tabbed binder(s) to the Owner's Representative for review and approval a minimum of 30 days before the planned training sessions.
  - 3. Provide training materials to Owner's Representative 7 days before the planned training sessions. Provide one set of materials for each trainee as directed by Owner, up to a maximum of 10 copies. Additional copies shall be provided at the cost of reproduction without mark-up if requested by Owner's Representative.
  - 4. Provide an Attendance Sign-in sheet as part of the training submittal package.
  - 5. Provide final training materials in electronic format. All documents shall be bookmarked for the sections as indicated above.
- E. Training Video
  - 1. Owner shall be authorized to record all demonstration and training sessions at Owner's option and expense.
  - 2. Video materials shall be provided in a format that allows for transfer to network storage and seamless access from internal cloud sites.

END OF SECTION

APPENDICES

FOLLOW

BELOW

# APPENDIX A: RATINGS

Description	Unit	Ratings	Remarks
Enclosure Ingress		NEMA3/ IP44 for enclosure	
Protection		IP2x between compartments	
Enclosure Color		RAL 7035 or ANSI 61 Light Grey	
Conformity &		Follow requirements for USA and local	
Compliance		requirements as stated in Specification 01	
		81 16 Facility Environmental	
		Requirements	
Time Stamping for		IEEE 1588 Network Time Protocol	
Signals			
Power Supply: Control,	V DC	125	two independent
Protection, Indication,			redundant
Breaker Charging and			sources
Truck Motors			
Power Supply: Internal	V AC	Single-phase 120VAC, 60Hz	
Lighting			

APPENDIX C: Commissioning Support Durations

Tests Performed	Per Unit / Per System	Duration		
I. Commissioning Level 4				
<ul> <li>EPMS/SCADA System Tests:</li> <li>Connectivity and Status Verification.</li> <li>CxA defined test scenarios.</li> </ul>	Per Switchgear/Electrical Room Location	4 days each location		
Protection System Tests	Per Switchgear/Electrical Room Location	2 Days each location		
II. Commissioning Level 5				
Integrated System Test (Coordination)	Building Phase	2 Day		
Integrated System Test (Functional)	Building Phase	10 Days		

# END OF APPENDICES

# SECTION 26 12 16

#### DRY TYPE STAND-ALONE MEDIUM VOLTAGE TRANSFORMERS

#### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. This section includes all labor, materials, equipment and services necessary for and incidental to furnishing, delivery and installation of newly manufactured dry-type, VPI, transient resistant, medium voltage transformer package.
- B. The Supplier's scope of work shall also include factory testing, delivery of the equipment to the job site at the designated location for unloading and installation by the Contractor, on-site system startup and site testing support.
- C. All equipment furnished shall comply with the performance requirements defined in Paragraph 1.3 and product requirements described in Part 2 of this specification and fit for the specific application.
- D. The Vendor shall not be required to provide the following:
  - 1. Buildings, foundations, or mounting framework
  - 2. Interconnecting wiring external to the enclosures of equipment specified herein.
  - 3. Labor and rigging for unloading and erection.
  - 4. Electrical energy.
- E. Manufacturer shall comply with the Standards, Codes and Guides referenced in this specification section 1.1F. Applicable documents include, but are not limited to, the latest version of all standards, codes and as well as all applicable sections and referenced standards within. Where conflicting information is presented, manufacturer is to comply with the most stringent of the conflicting standard, code, and/or guide.
- F. Compliance with the following Standards, Codes and Guides:
  - 1. Global Standards
    - a. Relevant Standards of International Code Council (ICC)
      - 1) International Building Code (IBC)
      - 2) ICC AC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
    - b. InterNational Electrical Testing Association (NETA):
      - 1) ANSI/NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
    - c. Relevant standards of the International Society of Automation (ISA).
      - 1) ANSI/ISA-71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
  - 2. Additional Standards for Sites in North America
    - a. Relevant standards of the Institute of Electrical and Electronics Engineers (IEEE) and in particular:
      - 1) IEEE C2 National Electrical Safety Code (NESC)

- 2) IEEE C57.12.01, general requirements for dry-type, VPI distribution and power transformers including those with solidly cast and or resinencapsulated windings.
- 3) IEEE C37.90.2 Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
- 4) ANSI/IEEE C57.12.10 Safety Requirements 230 kV and Below 833/958 through 8333/10417 kVA, Single-Phase and 750/862 through 60000/80000/100000kVA, Three-Phase without Load Tap Changing; and 3750/4687 Through 60000/80000/100000 kVA with Load Tap Changing.
- 5) ANSI/IEEE C57.12.70 Terminal Markings and Connections for Distribution and Power Transformers.
- 6) IEEE C57.12.91 Test Code for Dry-Type Distribution and Power Transformers
- b. Relevant standards of the National Electrical Manufacturers Association (NEMA), in particular:
  - 1) NEMA TR 1 Transformers, Regulators and Reactors
  - 2) NEMA 260 Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
  - 3) NEMA 250 Enclosures for Electrical Equipment (1000V Maximum)
  - 4) NEMA ICS 1 Industrial Control and Systems: General Requirements
  - 5) NEMA ICS 6 Industrial Controls and Systems: Enclosures
- c. Relevant Underwriters Laboratories Inc. (UL) Safety Standards:
  - 1) UL 50 Electrical Cabinets and Boxes
  - 2) UL 489 Standard for Molded Case Circuit Breakers
  - 3) UL 508 Industrial Control Equipment
  - 4) UL 840 Standards for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
  - 5) UL 891 Standard for Dead-front Switchboards
  - 6) UL XPLH Guide for Transformers, Distribution, Dry-type, VPI Type, over 600V
- d. National Fire Protection Association (NFPA)
  - 1) NFPA 70 National Electric Code
  - 2) NFPA 75 Fire Protection of Information Technology Equipment.
- e. Department of Energy
  - US Department of Energy, 10 CFR Part 431, Latest standard. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule

- 2) DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.
- EPACT 2016 United States Energy Policy Act 2016 / Guide for 3) Determining Energy Efficiency for Distribution Transformers
- f. Relevant Standards of the American Society of Civil Engineers (ASCE)
- ISCE/SEI 7 Minimum Design Loads for Buildings and Other Structures q.
- International Electrotechnical Commission (IEC) Standards, applicable where 3 adopted and in EU as a minimum:
  - IEC 60060 Test Techniques a.
  - IEC 60071 Insulation Coordination b.
  - IEC 60073 Basic and safety principles for man-machine interface, marking C. and identification. Coding principles for indicator and actuators.
  - IEC 60076 Power Transformers d.
  - IEC 60137 Insulated Bushings e.
  - IEC 60228 Insulated Conductors f.
  - IEC 60269 Low Voltage Fuses g.
  - IEC 60270 High Voltage Test h.
  - IEC 60282 High Voltage Current Limiting Fuses i.
  - IEC 60417/ISO 7000 Graphical Symbols for use on Equipment j.
  - IEC 60529 Enclosures k.
  - IEC 61869 Instrument Transformers Ι.
- In addition, compliance with requirements of the local code authority having 4. jurisdiction (A.H.J.) shall also be included if the A.H.J. requirements affect the manufacturing of the equipment.
- All other applicable codes and standards. 5.
- G. Drawings: Wherever the terms "Plans" or "Drawings" are used in these specifications, they shall refer to the Issued for Construction Drawings for this project. These Drawings together with this specification and other specifications make up the Procurement and/or Construction Documents for this project. The equipment proposed to be furnished under these specifications shall be compatible with the space provisions and wiring configurations as shown on these Drawings.
- The following specifications and documents contain information related to the Dry-type, Η. VPI Medium Voltage Transformers and the services specified herein:
  - General provisions of the Contract, including General and Supplementary 1. Conditions and Division 01 Specification Sections, apply to this Section.
  - 260511 Requirements for Electrical Installations 2.
  - 260572 Power System Studies 3.
  - 260800 Electrical Systems Commissioning Requirements 4.
  - 261300 Medium Voltage Circuit Breaker Switchgear 5.
  - 26 23 13 Low Voltage Switchgear 6.
  - Equipment submittals from other Suppliers. 7.
- 1.2 DEFINITIONS
  - The following terms appearing in this specification section shall have the following Α. meanings:
    - 1 "Manufacturer" or "Supplier" refers to the manufacturer, or his representative, of the specific equipment being described.

DRY TYPE STAND-ALONE MEDIUM VOLTAGE TRANSFORMERS 26 12 16

- 2. "Vendor" or "Seller" refers to the Manufacturer's authorized sales agent or distributor.
- 3. "Contractor" refers to the construction general contractor.
- 4. "Engineer" or "EOR" refers to the selected for the project Engineer of Record.
- 5. "Purchaser" or "Buyer" refers to Apple, Inc. or their representatives.
- 6. "Owner" refers to Apple, Inc.
- 7. "Utility" refers to the power company serving the selected project site.
- 8. "CxA" refers to Commissioning Agent
- 9. "LV" refers to Low Voltage
- 10. "MV" refers to Medium Voltage
- 11. "OFCI" or "OPCI" refers to Owner-Furnished/Procured Contractor-Installed
- 12. "SPD" refers to Surge protection device

# 1.3 SYSTEM DESCRIPTION, DESIGN AND PERFORMANCE REQUIREMENTS

- A. The Dry-type, VPI medium voltage transformer and the associated components specified herein shall be integrated into a single package from a single manufacturer with responsibility for entire equipment performance.
- B. The Dry-type, VPI MV Transformers shall consist of complete units in the quantities and capacities as shown on the Drawings. For the sake of simplicity, this Part Two of the Specifications may refer to a single Transformer, but it shall apply to all Dry-type, VPI MV Transformers within this project.
- C. The Transformers shall be capable of powering building critical loads as described herein.
- D. Equipment shall be designed and manufactured within the physical size as shown on the Drawings and shall be delivered to the site as a completed unit.
- E. Duration and magnitude of designed withstand capability shall be as outlined in ANSI C57.12 and the latest draft of the IEEE Short Circuit Test Code. The Transformers and associated bracing shall be individually designed using a design program developed and certified through a series of short circuit tests with test summary available upon request.
- F. Seismic-Restraint Design: Transformer assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces. Additional local requirements shall be as specified in Specification 01 81 16 Facility Environmental Data and in accordance with Section 26 05 48 Vibration and Seismic Controls for Electrical Equipment, where 26 05 48 provided.
- G. Naming Convention. The Owner will provide a naming convention for the supplied equipment. Drawings, documents and equipment identification shall utilize the Owner's naming convention.
- H. Maintainability
  - 1. All designs shall be undertaken to ensure that maintenance requirements are minimized and shall consider full life cycle costs including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified herein.
  - 2. The Supplier shall incorporate the following maintainability design concepts:
    - a. The equipment shall be able to be moved via a pallet in order to minimize the need to utilize excessive manpower or cranes for maintenance. In the event the equipment is too large or heavy to be transported via a pallet,

manufacturer shall include fixed equipment for handling bulky, heavy, and difficult to maneuver items.

- b. Components likely to require replacement during emergency repairs shall be readily accessible and marked.
- c. All designs shall be conducted to ensure ease of maintenance and provide comfort to maintenance personnel. This shall include, but not be limited to, the following:
- d. Equipment and accessories specified herein shall be designed for a life expectancy of 30 years as a minimum.

# 1.4 SUBMITTALS

- A. General
  - 1. Languages. English.
  - 2. All drawings and data shall be identified by the Owner's project name, job location, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each drawing shall be made by such means as a triangle-enclosed revision number.
  - 3. Naming Convention. The Owner will provide a naming convention for the supplied equipment. All drawings and documents shall reflect the naming convention.
  - 4. Electronic format.
    - a. File names shall be intuitive and clearly identify the document.
    - b. All documents are required to be provided as ISO Portable Data Format (PDF) files.
    - c. Native format. Where native format is requested, the format should be the original editable format for the software product used to develop the document, drawing or model, including, but not limited to Autodesk AutoCAD; Autodesk Revit; MS Office; Keynote, Pages, Numbers, etc. Native format is mandatory for CDE and pricing documents and when requested for other documents and drawings.
  - 5. All conflicts and discrepancies between the requirements of this Specification, Drawings, codes and standards and Purchase Order shall be referred to Engineer and the Owner for clarification before proceeding with the manufacturing of the affected parts.
- B. Submittal. Following the requirements herein, as a minimum, provide the information listed below in electronic format in English language.
  - 1. Technical Review:
    - a. Compliance-Deviation-Exception (CDE) markup for the main specification and all appendices to the specification.
      - 1) "C": By stating "compliance", the Manufacturer agrees to furnish the item or the feature as specified with no variation.
      - 2) "D": By stating "deviation", the Manufacturer proposes to furnish the item or the feature in a different way, while still meeting or exceeding the intended purpose of the product. The Manufacturer shall describe the reason for the deviation and the advantages/disadvantages of the proposed solution. Deviation should clearly reference specification section and line item. Stating deviation does not mean or imply acceptance by the Purchaser.
- "E": By stating "exception", the Manufacturer's intention is not to 3) furnish the item, the feature or the services specified. The Manufacturer shall describe the reason for the exception. Exemption should clearly reference specification section and line item. Stating exception does not mean or imply acceptance by the Purchaser.
- If nothing is stated, it is assumed that the Manufacturer states 4) "compliance". If there are contradictions in the statements, it is assumed that the statement that favors the Purchaser takes precedence.
- 2. Codes and Standards Compliance Statement. The Supplier shall state that their product is compliant with the codes and standards for the specific site location including local jurisdictional requirements
- Drawings and Design Data including but not limited to: 3.
  - Single line and three-line diagrams. a.
  - Plans, elevations, sections and details showing dimensions, minimum b. clearances, entry provisions for field connections, gutter space, installed features and devices, weights, center of gravity, lifting and handling provisions and requirements, for each assembly specified. Specifications for the method of placing and anchoring the equipment to the building structure, including an indication of the highest UBC Seismic Zone for which anchorage method is rated.
  - Power Cable Size and Termination Drawings for field connections. C.
- 4. Data sheets providing as a minimum the parameters listed in Appendix A.
  - Bill of materials. a.
    - 1) Suppliers/Manufacturers of all major components including generation/product line.
  - b. Instruction Manual for Installation.
  - Declaration of Conformity and product certifications. C.
  - d. Type test reports.
- Catalog data of proposed equipment. 5.
- C. Manufacturer's drawings and design documents shall be submitted for approval within 30 days of issuance of a purchase order.

#### 1.5 QUALITY ASSURANCE

- Manufacturer Qualifications: Maintain a service center capable of providing training, Α. parts, and emergency maintenance repairs within a response period of less than four (4) hours from time of notification.
- Prototype and Mock-up: If this is the first time a Supplier proposes to supply the specified Β. equipment, the Supplier at Supplier's expense shall demonstrate on a fully functional unit the ability to meet all the requirements of this specification.
- C. Testing Agency Qualifications: Member company of Inter-National Electrical Testing Association (NETA) or Nationally Recognized Testing Laboratory (NRTL).
  - Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-1. site testina.

- D. Electrical Components, Devices, Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Regulatory Requirements:
  - 1. UL 50
  - 2. UL 96A
  - 3. UL 508
  - 4. UL 840
  - 5. UL 1062
  - 6. NEC 450-23
  - 7. National Fire Protection Association (NFPA)
    - a. NFPA 70 National Electric Code
    - b. NFPA 780 Installation of Lightning Protection Systems
    - c. NFPA 75 Fire Protection of Information Technology Equipment.
  - 8. ASCE/SEI 7
  - 9. International Building Code (IBC) 2012
  - 10. Department of Energy
    - a. US Department of Energy, 10 CFR Part 431
    - b. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under 0 to Subpart K of 10 CFR part 431.
    - c. EPACT 2016
  - 11. In addition, compliance with requirements of the local code authority having jurisdiction (A.H.J.) shall also be included if the A.H.J. requirements affect the manufacturing of the equipment.
- F. Conformity and compliance. Electrical Components, Devices, and Accessories shall be listed and marked as follows:
  - 1. North America: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Global: FM Approved
- 1.6 DELIVERY, STORAGE, AND HANDLING
  - A. Identify shipment with Company's purchase order number, Owner project name, and unit/tag number, following the project naming convention.
  - B. Ship all equipment properly packed in tightly sealed, heavy gauge plastic or other type of liquid proof cover to protect the equipment from handling, shock, vibration, corrosion, rain, dust, and other foreign material.
  - C. When assemblies are supplied that require disassembly for installation or are shipped disassembled, each piece of the subassembly so affected will be uniquely identified as to its assembly position.
  - D. Box, crate or otherwise completely enclose and protect any loose components and spare parts. Clearly mark all equipment and provide complete installation instructions for any parts shipped separately from the main assembly.
  - E. Adequately brace each shipping unit both internally and externally to prevent damage during shipping, handling, storage or in the process of erection.
  - F. Clearly mark all shipping blocks, binding, etc. so that removal is assured. Identify any special precautions that must be observed when removing shipping constraints.

- G. Provide all shipping units with provisions for lifting and or skidding into place. Clearly mark all lifting points.
- H. Furnish unique installation materials and tools where required for the installation and commissioning of the equipment.
- I. Coordinate the delivery with the installing contractor with proper notifications for status of delivery. Installing contractor will be responsible for unloading and placing equipment at its final location. Supplier shall be responsible for compliance with local trucking and delivery requirements.
- J. The Supplier shall be responsible for the repair or replacement at their expense of all damage due to improper preparation, packing or damage while in transport.
- K. The Contractor shall be responsible for receiving and storing the equipment until installation. The specified equipment shall be kept dry and clean at all times. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

## 1.7 SITE CONDITIONS

A. System shall be designed for the Site Conditions. See Specification 01 81 16 Facility Environmental Data for site data and environmental conditions.

#### 1.8 SEQUENCING AND SCHEDULING

- A. The Supplier shall be responsible to coordinate production, testing and delivery schedule with the Contractor, Engineer and the Owner to ensure on-time delivery of the equipment to match the construction schedule. The Supplier shall provide regular schedule updates and notifications for potential schedule delays.
- B. The Contractor shall provide up to date schedules to the Supplier on a regular basis and on a monthly basis as a minimum.

## 1.9 WARRANTY

- A. Warranty the specified equipment and all other associated equipment as specified herein to be free from defects in materials, workmanship and non-performance per the requirements of this Specification for a minimum of 1 year after written acceptance by the Owner. In the event, any defects are discovered by the Owner within 1 year from acceptance of such equipment, the Manufacturer shall repair or replace, at Owner's option, defective products at no cost to the Owner.
- B. If at any time during the first one (1) year of commercial operation as defined below, the Owner shall accumulate sufficient evidence to reasonably indicate that the equipment or any part thereof is not in accordance with the specifications, the Owner will so notify the Supplier in writing, and the Supplier shall repair or replace the defective components. The cost of removal, reinstallation and complete re-testing of the equipment and any associated freight charges or service engineering charges, shall be at the Supplier's expense. The guarantee for the repaired or replaced equipment shall be extended for one year from the completion of repairs or replacement.
- C. Complete re-testing, as referred to in this section shall mean site acceptance testing as stipulated in testing portions of this specification including commissioning activities. The conditions that apply to original testing requirements shall also apply to the re-testing of

any equipment performed under the conditions of this guarantee. The cost of this retesting shall be made at the Vendor's expense.

- D. Commercial operation is defined as commencing on the date on which the equipment covered by these specifications has successfully completed final site acceptance testing and has received written acceptance by the Owner.
- E. Furnish warranty covering all costs for repair, parts, labor, testing equipment, travel, and living expenses for the manufacturer's service personnel. Performance of warranty work shall not be restricted to normal working hours but shall be at the Owners choosing including overtime and weekend hours at no additional cost to the Owner.
- F. Replacement parts shall be of the same manufacture as provided by the original Vendor/Supplier.
- G. The name, address and twenty-four (24) hour telephone number of the nearest authorized service organization shall be displayed on the inside of the door of each enclosure.

# 1.10 SYSTEM START UP AND COMMISSIONING

- A. Commissioning Levels:
  - 1. Level 1 Factory Tests
    - a. Factory Acceptance Test The Supplier is responsible for developing and implementing all tests to ensure that equipment quality is maintained prior to delivery to the Owner site and to confirm the Owner equipment specification requirements are confirmed and documented.
    - b. Factory Witness Test The scope of this test is developed by the Owner or Owner's representative. This test is specifically a site visit by the Owner, the Owner's Representative or Engineer.
  - 2. Level 2 Equipment Installation the General Contractor (GC) shall have processes to ensure the equipment is received, stored, installed and made ready for the equipment Supplier to perform their site startup.
  - 3. Level 3 Supplier Startup the equipment Supplier shall have procedures and methods to ensure the equipment is started, adjusted and performance is validated on site.
  - 4. Level 4 Equipment Specific Commissioning The Supplier, GC and Owner CxA shall coordinate the validation of the installed equipment. The CxA shall direct the commissioning test with the assistance and support of the GC and the Supplier.
  - 5. Level 5 Integrated System Testing The Owner CxA shall develop tests that ensure multiple systems, subsystems and components work as integrated systems. The GC and Supplier(s) shall assist and support these tests.

## 1.11 MAINTENANCE

- A. Extra Materials and Spare Parts
  - 1. Manufacturer to develop list of recommended extra materials and spare parts. List to include per unit pricing.

## PART 2 - PRODUCTS

- 2.1 GENERAL REQUIREMENTS
  - A. This section defines the general requirements for the products. See Appendix A for specific project-based product rating requirements. See Appendix A for schematics

DRY TYPE STAND-ALONE MEDIUM VOLTAGE TRANSFORMERS

clarifying the requirements. The appendices are an integral part to this specification and shall be considered as such.

- Β. The new Transformers for this site shall consist of new independent Transformers. These Transformers shall be manufactured and tested in strict accordance with these Specifications. The equipment specified herein consists of:
  - Medium voltage, Dry-type, VPI Medium Voltage Transformers serving loads via 1 output feeder fed switchboards in the quantities and capacities as shown in Appendix A.
  - 2. Each Medium Voltage Transformer shall have an ambient air-cooled base power rating as shown in Appendix A.
  - 3. Medium Voltage Transformers be suitable for solidly grounded operation as indicated on the Drawings.
  - 4. The Transformers shall be configured with primary input and secondary output as indicated on the Drawings, in Appendix A.
  - The construction of the Medium Voltage Transformers shall be "hardened" in terms 5. of core-and-coil design and use of insulating materials, in order to be capable of withstanding transient over-voltages associated with switching by upstream vacuum breakers, without use of external "snubber" networks. All components and devices within the enclosure shall be upgraded by at least one level above ANSI minimum B.I.L. standards. All primary leads shall be double-insulated and carefully routed to maximize spacing between adjacent phases and between phases and grounded parts.
  - 6. Provide separate line item cost amount, indicating if cost is an add or deduction, and include data sheets, revised dimensioned layout drawings to provide "snubber" network in lieu of "hardened" transformer. The intent is to provide a base price that includes the "hardened" transformer design, if possible.
  - Primary power shall be delivered to the Transformers via underground medium 7. voltage cables. The Transformers shall incorporate cable termination compartment containing minimum 200A rated, insulated, copper phase busbars for single incoming feeder cables, suitable for 2-hole termination lugs.
  - The Transformers shall be fitted with dead front enclosure for primary input 8. terminations, secondary terminations. The enclosure shall present a unified and clean appearance to the Transformers. The compartments shall include:
    - Adequate interior clearance for all enclosed items and required wire bending a. space.
    - Ventilation means as appropriate. b.
  - 9 Duration and magnitude of designed withstand capability shall be as outlined in ANSI and the latest draft of the IEEE Short Circuit Test Code. The Transformers and associated bracing shall be individually designed using a design program developed and certified through a series of short circuit tests with test summary available upon request.
  - 10. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of as identified in in Appendix A.
  - Wherever these Specifications refer to a single Transformer, it shall apply to all 11. Medium Voltage Transformers that appear on the Drawings and indicated as part of the scope of this project.
  - If conflicts exist between this Specification and the Drawings or actual conditions, 12. the matter shall immediately be referred to the Engineer for resolution. Unless notified by the Engineer to the contrary, the most restrictive requirement shall govern.

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## 2.2 SYSTEM REQUIREMENTS

- A. Transformer Type: Medium Voltage Dry-type, VPI, 2-winding transformers, capacity, frequency, primary, and secondary voltages as indicated in in Appendix A.
- B. Nominal transformer impedance shall be as indicated in in Appendix A.
- C. Transformer ratings shall be based on a maximum ambient and an average ambient for any twenty-four hour period as specified in in Appendix A. Continuous operation shall be at rated output kVA and 90% thru 105% normal rated output voltage, without exceeding designed temperature rise (assuming load power factor of 80% or higher). The Transformers shall carry their continuous rating and a hotspot winding temperature rise that will not exceed the values specified in in Appendix A.
- D. Transformer shall have BIL rating, Current rating, and Bus Fault Amp Bracing for the secondary section in accordance with in Appendix A.
- E. Sound level and voltage connections will be in accordance with NEMA Standards.
- F. Full-Capacity Voltage Taps: Four 2-hole bolted nominal 1.5 percent taps, 2 above and 2 below rated primary voltage. Unused tap bus bars shall be double insulated . All factory tap leads and termination lugs shall be completely double-insulated.
- G. Medium Voltage Transformer Finish Requirements:
  - 1. All steel parts shall be thoroughly cleaned, degreased and phosphatized by being passed through a hot phosphate chemical bath and rinse. After completely drying, the metal shall be uniformly coated with a polyester-base, urethane, or acrylic paint material. Thickness shall be uniform and shall comply with recommendations of the paint manufacturer to minimize "orange peel" and to prevent chipping, bleed-through, and rusting. In general, paint thickness shall be not less than 2 mils on any metal surface. After coating, the paint shall be cured as specified by the paint manufacturer.
  - 2. Color shall be as defined in in Appendix A.
  - 3. Preparation and Painting:
    - a. All external welds shall be ground smooth and all sharp corners eliminated.
    - b. All surfaces shall be clean and smooth and cleared of all blemishes before application of the finish.
    - c. Metal parts of all enclosures shall be thoroughly cleaned and painted with two coats of rust resistant primer, or rust-proofed by an equivalent process, followed by two finishing coats of durable baked enamel inside and out.
    - d. Primers for steel and iron surfaces shall be suitable for the service and operating temperatures to be encountered during the life of the equipment.
    - e. Self-contained or enclosed components shall be shop primed and finished. Surfaces that will be inaccessible after assembly will be painted or otherwise protected before assembly by a method that provides protection for the life of the equipment.

#### 2.3 PRIMARY VOLTAGE COMPONENTS

A. The Transformers shall be furnished with dead-front primary compartment. Primary compartment shall include incoming cable entrance space for underground or overhead service feeder conduits. They shall enclose the Transformer's primary termination bus bars.

- B. The primary compartment shall be front accessible, built to NEMA 1 standards. It shall be located on the side of the Transformer opposite from the secondary sections or on the front of the transformer as detailed on the Drawings.
- C. The primary terminal compartments shall contain power connection in accordance with in Appendix A. The surge arrestor bushings shall be connected directly to the primary windings for maximum effectiveness of surge protection. The medium voltage phase bus bars shall be spaced horizontally or diagonally at spacing appropriate for the BIL rating of the primary voltage.
- D. A ground pad shall be provided in the primary compartment suitable for landing ground wires and shield drain wires from incoming feeders.

## 2.4 ACCESSORIES, CONTROLS, AND INSTRUMENTS

- A. The Transformers shall be provided with the following accessories:1. Ground pads in both the HV compartment and secondary enclosure.
- 2.5 SOURCE QUALITY CONTROL
  - A. The Owner, and its representatives shall have the right to inspect all equipment covered by this Specification at any time and to witness any tests made on the equipment. The Manufacturer shall notify the Owner in writing at least 10 working days prior to shipment to permit the Owner the option of inspecting the equipment at the factory.
  - B. Type Test. If this is the first time a unit is supplied to the Owner or it is a newer generation unit, a type test shall be performed. The Owner may witness a type test and review results of the type test. Performing a type test does not guarantee purchase of equipment. As a minimum the following items shall be covered in a type test:
    - 1. The following test are not required if these tests have been conducted on a similar unit of same kVA and voltage ratings and the tests results are submitted for approval:
      - a. Impulse tests
      - b. Corona (partial discharge) tests using the radio influence voltage (RIV) techniques
  - C. Factory Tests: Design and routine tests shall comply with referenced standards. Prior to the shipment, perform factory tests.
    - 1. Tests to be performed by the Transformer Manufacturer:
      - a. Dielectric Test
      - b. Resistance Test
      - c. Polarity and Phase Rotation Test
      - d. Turn Ratio Test
      - e. Exciting Current Test
      - f. Applied Potential Test
      - g. Induce Voltage Test
      - h. Impedance Voltage Test
      - i. Temperature Test: Performed at full load on lowest tap setting
      - j. Sound-Level Tests: Conduct sound-level tests on equipment. Comply with IEEE C57.12.91 and NEMA ST 20.
  - D. The Manufacturer shall furnish the Engineer with 30 days advance notification of final assembly and testing and provide for approval: factory test procedures, drawings, documents, Material Safety Data Sheets and a certificate of compliance.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- Α. The Manufacturer shall provide installation instructions and assist the Contractor with the interpretation of the instructions and provide installation clarifications as required.
- Β. In addition to the Manufacturer's instructions, the Contractor shall comply with the following:
  - 1. Examination
    - Examine areas and conditions, with Installer present, for compliance with a. requirements for conditions affecting performance of the Medium Voltage Transformer.
    - Proceed with installation only after unsatisfactory conditions have been b. corrected.
  - 2. Preparation
    - Floor mounting location needs to be prepared within the manufacturer's a. requirements for installation.
    - b. Floor elevation and support to be in accordance with manufacturers requirements.
  - 3. Equipment Mounting: Install Medium Voltage Transformer on leveled finished floor.
    - For supported equipment, install epoxy-coated anchor bolts and anchor into a. structural concrete floor.
    - Place and secure anchorage devices. Use setting drawings, templates, b. diagrams, instructions, and directions furnished with items to be embedded.
    - Install anchor bolts to elevations required for proper attachment to supported C. equipment.
  - 4. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and applicable codes and standards.
  - 5. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
  - 6. Grounding
    - Separately Derived Systems: If not part of a listed power supply for a dataa. processing room, comply with NFPA 70 or local requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.
  - 7. Identification
    - a. Identify components and wiring according to the project specific Identification for Electrical Systems requirements.
  - The Contractor shall refer to the appropriate construction specifications and 8. drawings for the installation requirements for conduits, wire, terminations, boxes and testing. Connect equipment ground buses to common building ground system. Tighten bus joint, connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
  - 9. The Contractor shall exercise extreme care in the protection of Medium Voltage Transformer equipment during installation. At no time shall personnel be allowed to sit or stand on equipment enclosures or use them as support for working above. Internal components, especially printed circuit cards, coils and windings, shall be kept clear of dust, filings and other construction debris.

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- 10. Temporary Heating: Apply temporary heat to the equipment, according to manufacturer's written recommendations, throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.
- 11. Efforts shall be implemented to protect the equipment from dust and dirt during transport, storage and installation, due to the construction environment. Unit should be protected / covered when there is no active work on the unit during installation
- 12. Cleaning: Inspect interior and exterior of installed equipment. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. The equipment shall be given a thorough cleaning prior to final testing.
- 13. Equipment Maintenance: Equipment is to be maintained to the manufacturer's recommendations during commissioning process. Manufacturer to provide equipment storage, handling, and maintenance information prior to shipment

# 3.2 MANUFACTURER'S FIELD SERVICE

- A. Maintain a local competent service organization, capable of providing quality service and replacement parts. Availability and response times and additional service requirements shall be as specified in other sections.
- B. The Manufacturer shall attend a schedule coordination meeting at the site prior to start of construction for the purpose of integrating installation schedule of other Suppliers and the Contractor.
- C. A qualified manufacturer's field representative shall be on-site at the start of construction to observe installation of Medium Voltage Transformer lineup, inspect, test, adjust components and assemblies and facilitate on-site support from installation through various levels of Commissioning activities. Site testing may require weekend or overtime work.
- D. During Medium Voltage Transformer startup and if repair required, field service must be unlimited and must continue until satisfactory system operation and Engineer's approval has been achieved.
- E. The time for on-site support through construction and commissioning period shall be indicated in the scope of work and base bid price.

## 3.3 FIELD QUALITY CONTROL

- A. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner. The Purchaser/Owner reserves the right of rejection at the job site if the above conditions are discovered even after acceptance at the factory.
- B. Testing Agency: The Owner will engage a qualified Commissioning Agent to perform tests and inspections. The MV Transformer manufacturer shall be responsible for assisting the Commissioning Agent and supporting all the site tests.

# 3.4 SITE TESTING & COMMISSIONING

A. General Requirements

- 1. Provide installation and startup checklists to the Owner and General Contractor for their review and acceptance, prior to commencing Level 4 Commissioning.
- 2. Review and comment on Level 4 testing scripts provided by the Commissioning Agent.
- 3. The Contractor shall provide electrical trade labor for site tests.
- B. Equipment Installation (Level 2 Commissioning)
  - Upon delivery, inspect equipment for:
    - a. Equipment shipped matches the equipment tested during Level 1 FAT
    - b. There are no alterations to the equipment after Level 1 FAT
    - c. There is no damage to the equipment from transportation
    - d. Equipment that was tested in the factory as a group shall be installed as a group.
    - e. Confirm the tilt, shock and vibration devices show no abnormal shocks or tilts during transit.
  - 2. After installation, check and verify:
    - a. Equipment installed in accordance with the Manufacturer's requirements Complete installation and startup checks according to manufacturer's written instructions.
    - b. Equipment installed in accordance with drawings, plans and specifications
    - c. Installation is compliant with local codes and standards and health and safety requirements.
    - d. Equipment is accessible for operation and maintenance
    - e. Perform visual and mechanical inspections on the complete Medium Voltage Transformer installation including transformer assembly, LV enclosure, instruments and controls, input and output connections, and all other associated equipment and components.
    - f. Verify that electrical wiring installation complies with manufacturer's submittal and with written installation requirements in other electrical Sections.
- C. Vendor Startup (Level 3 Commissioning)
  - 1. Develop and update check lists and scripts for Level 3 Testing
  - 2. Verify connections and integration with the input and output switchgear.
  - 3. Set field-adjustable settings in accordance with Engineer approved parameters and applicable protection device trip ranges as indicated.
  - 4. Power up and verify operation of each Medium Voltage Transformer.
  - 5. Functional check of all power train components, to determine proper operation.
  - 6. Simulate malfunctions and failures to verify the proper operation of protective devices. Indicate on test form which protective devices were tested, how they were simulated, and the resulting operation of the system. Record all trip points.
  - 7. Verify operation of hardwired and Ethernet interfaces. Confirm proper communication and readings at SCADA/ENMS/EPMS. Provide alarm logs confirming trip points tested.
  - 8. Perform 24 Hour "Soak" of transformer after energization with no secondary load present
  - 9. NETA Testing. Engage a NETA certified testing company, this can be coordinated with the Contractor, to perform the following tests:
    - a. Transformer Inspection
    - b. Transformer Turns Ration Test
    - c. Transformer Dielectric Resistance Test (PI)
    - d. Transformer Winding Resistance Test

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- e. Transformer Power Factor Test
- D. Functional System Testing (Level 4 Commissioning)
  - 1. Reference Division 26 Electrical Systems Commissioning Requirements for testing additional testing information, roles, and responsibilities.
  - 2. Medium Voltage Transformer vendor to provide support for Level 3 Commissioning. Per section 1.10 Warranty, if the equipment fails to meet listed specifications and performance re-testing shall be performed at Vendors expense. Vendor is responsible for any repairs or corrections.
  - 3. Commissioning tests:
    - a. Secondary Voltage Verification
    - b. CxA to provide list of indications, parameter values, and system responses considered satisfactory for each test action. Included will be tabulation of actual observations during test.
- E. Level 5 Integrated System Testing (IST)
  - 1. Following the completion of all system and component testing and before applying critical load to the system an overall Integrated System Test (IST) will be conducted on the complete critical electrical distribution system.
  - 2. Reference Division 26 Electrical Systems Commissioning Requirements for testing additional testing information, roles, and responsibilities.

# 3.5 ELECTRICAL FIELD TEST REPORTS

- A. The Manufacturer, Supplier and independent testing agencies shall supply their certified test reports and data for each of the factory and site tests conducted by them as specified herein.
  - 1. Test Reports
    - a. All test data shall be recorded and certified by the Manufacturer or testing agency conducting the aforementioned tests. Any defects noted during the tests performed shall be brought to the attention of the Engineer for corrective action. Submit electronic and three (3) hard copies and soft copies (.pdf format) of all test reports for approval and/or corrective actions.
    - b. Each test report set submitted shall be clearly identified by the Purchaser's name, the project name, the purchase order numbers, the equipment description and specific identification, and the manufacturer's name and address. Each individual document shall be legible and shall have reproducible capability.

# END OF SECTION

# APPENDICES FOLLOW BELOW

Appendix A: Transformer RATINGS

Description	Unit	Rating	Remarks		
I. General					
Transformer Primary	V	4,160 V, 3-wire + ground			
Voltage					
Transformer Secondary	V	480Y, 3-wire + ground			
Voltage					
Transformer Operating	Hz	60 Hz			
Frequency					
Transformer Configuration	-	3 Phase Delta – Wye			
Transformer Construction	-	VPI			
Hardness for Distortion		K-1	ANSI/IEEE C57.11- 1986		
Transformer kVA	kVA	150 kVA			
Conformity & Compliance		Follow requirements for geographic location specified in			
		Specification 01 81 16 Facility			
		Environmental Data			
Busbar All Sections - Minimum Rating	A	225 A	For low voltage transformer		
		-	connections.		
Busbar All Sections - Material	-	Copper			
Secondary Cable	-	Two-hole, long barrel, double			
Terminations		crimp compression type lug			
		terminations with viewing window			
Primary Terminations	-	Cable Terminations			
Paint Color	-	RAL 7035 Light Gray			
II. System Requirements					

Short Circuit Impedance % Min 3% ±0.5

Vector Group



Transformer Temperature Rise Characteristics	-	Class H (maximum winding temperature 220°C) Insulation system 150°C maximum temperature rise at Full Load and maximum Ambient	
Average Ambient	С	30°C	

Maximum Ambient	С	40°C	
Transformer Efficiency	%	99.0%	Full load efficiency
Equipment Voltage Class	kV	5 kV	
Primary Component Basic Impulse Level (BIL)	kV	60 kV	
Primary 1 Minute Withstand Voltage	kV	38 kV	Power Frequency
Primary Component Maximum Continuous Voltage	kV	11 KV	
Secondary Winding 1 minute withstand Voltage	KV	1.2 KV	Power Frequency
Transformer secondary Current	A	180 A	
Secondary Bus Fault Bracing	kA	35 kA	
Winding Material		Aluminum / Aluminum	Terminations for copper conductors

<u>, , , , , , , , , , , , , , , , , , , </u>					
No.	Factory Witness/Acceptance Tests				
1.	Test Description	Criteria			
2.	Electrical Testing	In accordance with Manufacturers published results			
3.	Transformer Efficiency	Efficiency ≥99.0%			
5.	Sound Level	Comply with IEEE C57.12.91 and NEMA ST 20			
	Level 3 Commissioning Tests				
	Test Description Criteria				
7.	Electrical Testing	In accordance with Manufacturers	Duration of testing per		
		published results	Manufacturer		
8.	Electrical Testing	In accordance with NETA	Duration of testing per NETA		
		Standards	testing firm		

# Appendix B: Test Result Criteria & Commissioning Duration

END OF APPENDICES

# SECTION 26 12 19

# PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.
- B. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismicload, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
  - 3. Section 013100 "Project Management and Coordination" for preinstallation conference procedures.

#### 1.2 DEFINITIONS

- A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.
- B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."
- C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).
- D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).
- E. Elbow Connector: See "bushing elbow" above.

#### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. For each type of product.
    - a. Include rated capacities, operating characteristics, and furnished specialties and accessories.

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- B. Shop Drawings:
  - 1. For pad-mounted, liquid-filled, medium-voltage transformers.
    - a. Include plans and elevations showing major components and features.
      - Include plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.
    - b. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
    - c. Include single-line diagram.
    - d. Include list of materials.
    - e. Include nameplate data.
    - f. Manufacturer's published time-current curves of transformer line-side fuses, with transformer damage curve, inrush curve, and thru fault current indicated.
- C. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For transformers, signed by product manufacturer.
- B. Source quality-control reports.

# PART 2 - PRODUCTS

- 2.1 SYSTEM DESCRIPTION
  - A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - B. Comply with IEEE C2.
  - C. Comply with IEEE C57.12.00.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Windings Material: Aluminum.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.
- C. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
- D. Efficiency: Comply with 10 CFR 431, Subpart K.

- E. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.
- F. Tap Changer: External handle, for de-energized operation.
- G. Tank: Sealed, with welded-on cover. Designed to withstand internal pressure of not less than 7 psi without permanent distortion and 15 psig without rupture. Comply with IEEE C57.12.36.
- H. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.
- I. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.
- J. Insulating Liquids:
  - 1. Less-Flammable Liquids:
    - a. Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.
- K. Sound level must comply with NEMA TR 1 requirements.
- L. Corrosion Protection:
  - 1. Transformer coating system must be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

## 2.3 THREE-PHASE TRANSFORMERS

- A. Manufacturers: Subject to compliance with requirements, Basis of Design is Eaton's Cooper Power Series, provide products by one of the following:
  - 1. ERMCO-ECI.
  - 2. Eaton's Cooper Power Series.
  - 3. GE Power; General Electric Company.
  - 4. Hitachi ABB Power Grids Ltd.; ABB & Hitachi Joint Venture.
  - 5. SqD; Schneider Electric
- B. Description:
  - 1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 2. Comply with IEEE C57.12.26.
- C. Compartment Construction:
  - 1. Double-Compartment Construction: Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with stop in open position and provision for padlocking.

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- D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.
  - 1. 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
  - 2. Interrupting Rating: 50 000 A(rms sym) at system voltage.
  - 3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperature to provide thermal protection to transformer. Connect current-limiting fuses ahead of radial-feed load-break switch.
  - 4. Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed and external drip shield is installed.
  - 5. Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.
- E. Line-Side Section: Dead-front design.
  - 1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
  - 2. Bushing inserts:
    - a. Conform to requirements of IEEE 386.
    - b. Rated at 200 Å, with voltage class matching connectors. Provide parking stand near bushing wells. Parking stands must be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.
    - c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.
  - 3. Bushing wells configured for loop-feed application.
  - 4. Access to liquid-immersed fuses.
  - 5. Dead-front surge arresters.
  - 6. Tap-changer operator.
  - 7. Load-Break Switch:
    - a. Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with continuous current rating and load-break rating of 200 A, and make-and-latch rating of 12 kA(rms sym).
  - 8. Ground pad.
- F. Load-Side Section:
  - 1. Bushings with spade terminals drilled for terminating number of conductors indicated on Drawings, and lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- G. Capacities and Characteristics:
  - 1. Power Rating: 2500 kVA.
  - 2. Voltage Ratings: 12k V 4160- V.
  - 3. Taps: Comply with IEEE C57.12.26 requirements.
  - 4. Transformer BIL (kV): Comply with IEEE C57.12.26 requirements.
  - 5. Minimum Tested Impedance (Percent) at 85 deg C: 5.75.
  - 6. Comply with FM Global Class No. 3990.
- H. Transformer Accessories:
  - 1. Drain and filter connection.
  - 2. Filling and top filter press connections.

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- 3. Pressure-vacuum gauge.
- 4. Dial-type analog thermometer with alarm contacts.
- 5. Magnetic liquid level indicator with high and low alarm contacts.
- 6. Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer. With alarm contacts and manual bleeder.
- 7. Stainless steel ground connection pads.
- 8. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
- 9. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide with seal-in delay.

## 2.4 CONTROL NETWORK

A. Controllers: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as native device.

## 2.5 WARNING LABELS AND SIGNS

- A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
  - High-Voltage Warning Label: Provide self-adhesive warning signs on outside of line-side compartment door(s). Sign legend must be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Word "DANGER" must be in white letters on red background and words "HIGH VOLTAGE" must be in black letters on white background.
  - 2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of line-side compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

## 2.6 SOURCE QUALITY CONTROL

- A. Factory Tests and Inspections: Perform the following tests and inspections, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of qualified electrical testing laboratory's certification of system compliance on control units.
  - 1. Resistance.
  - 2. Turns ratio, polarity, and phase relation.
  - 3. Transformer no-load losses and excitation current at 100 percent of ratings.
  - 4. Transformer impedance voltage and load loss.
  - 5. Operation of devices.
  - 6. Lightning impulse.
  - 7. Low frequency.
  - 8. Leak.
  - 9. Perform Optional Tests:
    - a. Transformer no-load losses and excitation current at 110 percent of ratings.
    - b. Insulation power factor.
    - c. Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
    - d. Induced potential.

- e. Resistance measurements of windings on rated voltage connection and at tap extreme connections.
- f. Ratios on rated voltage connection and at tap extreme connections.
- g. Polarity and phase relation on rated voltage connection.
- h. No-load loss at rated voltage on rated voltage connection.
- i. Exciting current at rated voltage on rated voltage connection.
- j. Impedance.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.
  - 1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
  - 2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
  - 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
  - 4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
  - 5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
  - 6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
  - 7. Verify presence of polychlorinated biphenyl content labeling.
  - 8. Unload transformers carefully, observing packing label warnings and handling instructions.
  - 9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
  - 1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
  - 2. Protect transformer termination compartments against entrance of dust, rain, and snow.
  - 3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
  - 4. Verify that transformer weights are within rated capacity of handling equipment.
  - 5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
  - 6. Use jacks only at corners of tank base plate.

- 7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
- 8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
- 9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.
- C. Storage:
  - 1. Store transformers in accordance with manufacturer's recommendations.
  - 2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
  - 3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
  - 4. Store transformers with compartment doors closed.
  - 5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.
- D. Examine areas and space conditions for compliance with requirements for padmounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.
- E. Examine roughing-in of conduits and grounding systems to verify the following:
  - 1. Wiring entries comply with layout requirements.
  - 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.
- F. Examine concrete bases for suitable conditions for transformer installation.
- G. Pre-Installation Checks:
  - 1. Verify removal of shipping bracing after placement.
  - 2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:
    - a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
    - b. Acid Neutralization Number: ASTM D974.
    - c. Specific Gravity: ASTM D1298.
    - d. Interfacial Tension: ASTM D971.
    - e. Color: ASTM D1500.
    - f. Visual Condition: ASTM D1524.
    - g. Power Factor or Dissipation Factor: ASTM D924.
- H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5  $\Omega$  at transformer location.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
- B. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
- C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and IEEE C2.

## 3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than 30 inch below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
  - 2. Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner posts and at intervals not exceeding 10 ft. Bond gate sections to fence posts using 1/8 by 1 inch tinned flexible braided copper strap and clamps.
  - 3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
  - 4. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure.
  - 5. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
  - 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of transformers in accordance with Section 260513 "Medium-Voltage Cables."

#### 3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

B. Install warning signs as required to comply with 29 CFR 1910.269.

# 3.5 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. General Field-Testing Requirements:
    - a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
    - b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
    - c. After installing transformer but before primary is energized, verify that grounding system at transformer is tested at specified value or less.
    - d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
    - e. Visual and Mechanical Inspection:
      - 1) Verify equipment nameplate data complies with Contract Documents.
      - 2) Inspect bolted electrical connections for high resistance using one of the following two methods:
        - a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        - b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12.
          Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.
  - 2. Medium-Voltage Surge Arrester Field Tests:
    - a. Visual and Mechanical Inspection:
      - 1) Inspect physical and mechanical condition.
      - 2) Verify arresters are clean.
      - 3) Verify that ground leads on devices are individually attached to ground bus or ground electrode.
    - b. Electrical Test:
      - Perform insulation-resistance test on arresters, phase terminal-toground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
      - 2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
  - 3. Liquid-Filled Transformer Field Tests:
    - a. Visual and Mechanical Inspection:
      - 1) Test dew point of tank gases if applicable.
      - 2) Inspect anchorage, alignment, and grounding.
      - 3) Verify bushings are clean.

- 4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
- 5) Verify that liquid level in tanks is within manufacturer's published tolerances.
- 6) Perform specific inspections and mechanical tests recommended by manufacturer.
- 7) Verify presence of transformer surge arresters and that their ratings are as specified.
- 8) Verify that as-left tap connections are as specified.
- b. Electrical Tests:
  - 1) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
  - 2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
  - 3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values may not be less than 1 M $\Omega$  at 500 V(dc).
  - 4) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
  - 5) Perform Optional Field Tests:
    - Perform applied-voltage test on line- and load-side windings-toground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase wye-wye-connected transformers.
  - 6) Verify correct secondary voltage, phase-to-phase and phase-toneutral, after energization and prior to loading.
  - 7) Remove sample of insulating liquid in accordance with ASTM D923, and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.
- C. Nonconforming Work:
  - 1. Equipment and devices will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace malfunctioning units and retest.
- D. Prepare test and inspection reports. Record as-left set points of adjustable devices.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

# 3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

- During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
- 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
  - a. Adjust transformer taps.
  - b. Prepare written request for voltage adjustment by electric utility.
- 3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
- 4. Report:
  - a. Prepare written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.
  - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
  - 2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
  - 3. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:
    - a. Description of equipment to be tested.
    - b. Discrepancies.
    - c. Temperature difference between area of concern and reference area.
    - d. Probable cause of temperature difference.
    - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    - f. Identify load conditions at time of inspection.
    - g. Provide photographs and thermograms of deficient area.
  - 4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

# END OF SECTION

# SECTION 26 13 13

#### MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR

#### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section includes all labor, materials, equipment and services necessary for and incidental to design, furnishing, factory testing, delivery, unloading, installation, field testing, training and documentation of newly manufactured medium voltage switchgear.
- B. The Supplier shall not be required to provide the following:
  - 1. Buildings, foundations, or mounting framework
  - 2. Cable raceways, interconnecting cabling, wiring and materials external to the enclosures of equipment specified herein.
  - 3. Piping external to the equipment specified herein.
  - 4. Labor and rigging for unloading and erection.
  - 5. Electrical energy and/or fuel for site testing.
- C. Scope demarcation, interfaces and liaisons. See Specification 01 42 16 for definitions of the terms used in the table.

Responsibility	Switchgear Supplier	MV PDCS Supplier	DC Battery System Supplier	General Contractor	Cx Agent
Coordination	Provide	Provide	Provide	Provide and Manage	Provide
Switchgear Complete Package Supply	Provide	Provide Data Acquisition	Integrate	Provide and Manage	Oversee
EPMS/PDCS Integration	Coordinate interfaces, supply information to PDCS/SCADA/EP MS Supplier and support integration into their system	Perform	Integrate	Provide and Manage	Oversee
DC Battery System Sizing and Supply	Coordinate with and provide switchgear load data for battery sizing calculations	Support	Perform	Provide and Manage	Oversee
Switchgear Package Delivery	Provide	n/a	n/a	Provide and Manage	n/a
Switchgear Package Offloading and positioning on site	Provide	n/a	n/a	Provide and Manage	n/a
Switchgear Package	Support	Support controls part	n/a	Provide and Provide	n/a

Responsibility	Switchgear Supplier	MV PDCS Supplier	DC Battery System Supplier	General Contractor	Cx Agent
Installation and Connections					
Level 1a Commissioning: Factory Acceptance Test Switchgear	Provide	n/a	n/a	Provide and Manage	Witness
Level 1b Commissioning: Integrated Factory Acceptance Test (Switchgear Supplier Factory)	Provide space and accommodate EPMS/PDCS Equipment, Perform Switchgear Portion of the test and Support EPMS/PDCS Portion of the Test	Supply Equipment to Switchgear Facility and Perform EPMS/PD CS Portion of the test	n/a	Provide and Manage	Witness
Level 2 Commissioning: Field Installation Verification and Construction Tests	Support	-	n/a	Provide and Provide	Observe and Review Reports
Level 3 Commissioning: Equipment Startup	Provide	Support and verify signals to EPMS/PD CS system	Support	Provide and Manage	Support and Review Reports
Level 4 Commissioning: Functional System Testing	Support	Support	Support	Provide and Manage	Perform
Level 5 Commissioning: Integrated System Testing	Support	Support	Support	Provide and Manage	Perform
As built drawings, Operations and Maintenance Manuals	Provide	n/a	n/a	Provide and Manage	Oversee
Staff Training	Provide	n/a	n/a	Provide and Manage	Oversee

## 1.2 REFERENCES

A. Manufacturer shall comply with the Standards, Codes and Guides applicable for the project location. Applicable documents include, but are not limited to, the latest version of all standards, codes and as well as all applicable sections and referenced standards

within. Where conflicting information is presented, compliance with the most stringent of the conflicting standard, code, and/or guide is required.

- 1. Global Standards
  - a. International Organization for Standardization (ISO) Standards:
    - 1) ISO 9001 Quality Management Systems
    - 2) ISO 10005 Quality Management Systems. Guidelines for Quality Plans
  - b. Institute of Electrical and Electronics Engineers (IEEE)
    - 1) IEEE 1588 Precision Time Protocol (PTP)
  - c. Standards of International Code Council (ICC)
    - 1) International Building Code (IBC)
    - 2) ICC AC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
  - d. Standards of the International Society of Automation (ISA).
    - 1) ANSI/ISA-71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
  - e. Semiconductor Equipment and Materials International (SEMI)
    - 1) F47 Specification for Semiconductor Processing Equipment Voltage Sag Immunity
- 2. Additional Standards for Sites within jurisdictions following IEC standards
  - a. IEC 60071-2 Insulation co-ordination Part 2: Application guidelines
  - b. IEC 60282-1 High-voltage fuses Part 1: Current-limiting fuses
  - c. IEC 60529 Degrees of protection provided by enclosures (IP Code)
  - d. IEC 60050-151, International Electrotechnical Vocabulary Part 151: Electrical and magnetic devices
  - e. IEC 60050-441:1984, International Electrotechnical Vocabulary Chapter 441: Switchgear, controlgear and fuses
  - f. IEC 60060-1, High-voltage test techniques Part 1: General definitions and test requirements
  - g. IEC 60270, High-voltage test techniques Partial discharge measurements
  - h. IEC 60470:1999, High-voltage alternating current contactors and contactorbased motor starters
  - i. IEC 60529:1989, Degrees of protection provided by enclosures (IP Code)
  - j. IEC 62262, Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
  - k. IEC 62271-1:2007, High-voltage switchgear and control gear Part 1: Common specifications
  - I. IEC 62271-100, High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers
  - m. IEC 62271-102:2001, High-voltage switchgear and control gear Part 102: Alternating current disconnectors and earthing switches
  - n. IEC 62271-103, High-voltage switchgear and control gear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
  - o. IEC 62271-105, High-voltage switchgear and control gear Part 105: Alternating current switch-fuse combinations

- p. IEC 62271-106 High-voltage switchgear and control gear Part 106: Alternating current contactors, contactor-based controllers and motorstarters
- q. IEC 62271-200 High-voltage switchgear and control gear Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV.
- r. IEC 62271-200 class A accessibility, criteria 1 to 5 for arc proof
- s. IEC 62271-201:2006, High-voltage switchgear and control gear Part 201: AC insulation enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
- t. IEC/TS 62271-304, High-voltage switchgear and control gear Part 304: Design classes for indoor enclosed switchgear and control gear for rated voltages above 1 kV up to and including 52 kV to be used in severe climatic conditions
- u. ISO/IEC Guide 51:1999, Safety aspects Guidelines for their inclusion in standards
- v. IEC 61000-4-30 Testing and Measurement Techniques Power Quality Measurement Methods
- w. IEC 61850 International Standard defining communication protocols for intelligent electronic devices at electrical substations.
- x. IEC 60255-5 Electrical Relays Part 5: Insulation coordination for measuring relays and protection equipment Requirements and tests
- y. IEC EN 61000 Electromagnetic compatibility (EMC) Parts 3-2, 3-3, 4-2, 4-3, 4-4, 4-5, 4-6, 4-8, 4-11, 4-18
- z. IEC-60044-1 Current Transformers
- aa. IEC-60044-2 Inductive Voltage Transformers
- bb. IEC-60099-4 Metal-oxide surge arresters without gaps for a.c. systems
- 3. Additional Standards for Sites in the USA
  - a. National Fire Protection Association
    - 1) NFPA-70, NEC
  - b. National Electrical Manufacturers Association (NEMA), in particular:
    - 1) SG-4 Alternating-Current High-Voltage Circuit Breakers.
    - 2) SG-5 Power Switchgear Assemblies
    - 3) NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
  - c. American National Standards Institute (ANSI), in particular:
    - 1) ANSI C2 The National Electrical Safety Code
  - d. Institute of Electrical and Electronics Engineers (IEEE)
    - 1) IEEE 4 Standard Technique for High-Voltage Testing
    - 2) ANSI/IEEE Std C37.04 Standard Rating Structure for AC High-Voltage Circuit Breakers
    - IEEE Std C37.06 AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities

- 4) IEEE Std C37.06.1 Guide for High-Voltage Circuit Breakers rated on Symmetrical Current Basis Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times"
- 5) IEEE Std C37.09 Standard test procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
- 6) IEEE Std C37.010 Application Guide for AC High-Voltage Circuit Breakers on a Symmetrical Current Basis
- 7) IEEE Std C37.011 Application Guide for Transient Recovery Voltage for AC High-Voltage Circuit Breakers
- 8) IEEE Std C37.14 Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures
- 9) ANSI/IEEE Std C37.20.2 Standard for Metal-Clad Switchgear
- 10) IEEE Std C37.20.7 Guide for testing Metal-Enclosed Switchgear rated Up to 38 kV for Internal Arc Faults
- 11) IEEE Std C37.21 Standard for Control Switchboards
- 12) IEEE Std C37.23 Standard for Metal-Enclosed Bus
- 13) ANSI/IEEE C37.55 Medium Voltage Metal-Clad Assemblies Conformance Test Procedures
- 14) IEEE Std C37.90 Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- 15) IEEE Std C37.90.1 Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- 16) IEEE Std C37.90.2 Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- 17) IEEE Std C37.100 Standard Definitions for Power Switchgear
- 18) IEEE Std C37.101 Standard of Common Requirements for High Voltage Power Switchgear Rated Above 1000 V
- 19) ANSI/IEEE C57.12.28 Standard for Padmount Enclosures.
- 20) IEEE Std C57.12.91 Standard Test Code for Dry-Type Distribution and Power Transformers
- 21) IEEE Std C57.13 Standard Requirements for Instrument Transformers
- 22) IEEE Std C62.11 Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV)
- 23) ANSI C84.1 Standard for Electric Power Systems and Equipment Voltage ratings (60 Hertz)
- e. American Society of Testing and Materials (ASTM)
  - 1) D 3951 Standard Practice for Commercial Packaging
- f. Underwriters Laboratories Inc. (UL) Safety Standards

- 1) UL 347 High Voltage Industrial Control Equipment
- 2) UL 467 Grounding and Bonding Equipment
- 3) UL 44 Thermoset-Insulated Wires and Cables
- B. In addition, compliance with requirements of the local code authority having jurisdiction (A.H.J.) shall also be included if the A.H.J. requirements affect the manufacturing of the equipment.
- C. Project Contract Documents
  - 1. Drawings: Wherever the terms "Plans" or "Drawings" are used in these specifications, they shall refer to the Issued for Construction Drawings for this project. The equipment proposed to be furnished under these specifications shall be compatible with the space provisions, wiring configurations and other requirements as shown on these Drawings.
  - 2. Specifications. Other Contract specifications and documents contain information related to the equipment the services specified herein. Some are listed below:
    - a. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
    - b. Division 26
      - 1) 26 05 **xx** Common Work Results for Electrical, set of specifications
      - 2) 26 08 00 Electrical Systems Commissioning Requirements
      - 3) 26 09 13 Electrical Power/Network Monitoring System
      - 4) 26 09 16 Power Distribution Control System
      - 5) 26 23 13 Low Voltage Switchgear
      - 6) 26 32 13.13 Diesel-Engine-Driven Generator Sets
      - 7) 26 33 23 Central Battery System (Station Service)
  - 3. Sketches and supporting materials attached to this package and part of the IFC set including: protection details; cable requirements; replacement strategy and others.
- D. Equipment submittals from other Suppliers
- E. Where part of an OFCI package:
  - 1. OFCI Pricing Schedules
  - 2. CDE Template
- 1.3 DEFINITIONS
  - A. See Specification Section "01 42 16 Definitions" for project definitions.
  - B. See Specification Section "01 42 13.13 Equipment Abbreviations" for equipment abbreviations
  - C. "MV Switchgear" or "Medium Voltage Switchgear" refers to Switchgear for voltages above 1kV and up to 52kV.
- 1.4 SYSTEM DESCRIPTION, DESIGN AND PERFORMANCE REQUIREMENTS
  - A. Switchgear assemblies specified herein shall be integrated into a single package from a single manufacturer with responsibility for entire equipment installation and performance.

All metering, protection, operational devices, controls, interlocks and spare equipment as specified herein or as required to provide a safe, dependable, and properly functioning power system shall be provided.

- B. The equipment supplied shall be of a proven design that can meet the requirements specified and built, in accordance with the latest applicable standards and for the ambient conditions of the project site. Additional local requirements shall be as specified in Specification Section 01 81 16 Facility Environmental Data.
- C. Workmanship shall be of the best quality, free from any defects that might render the equipment unreliable, unsuitable or inefficient for serving data center loads. Best quality practices should be documented and followed, verification of these procedures should be provided to the Owner, if requested.
- D. Limiting Physical Dimensions. Please refer to the electrical and switchgear room layout drawings for details of limiting dimensions. The dimensions indicated on the drawings indicate the space allowances available and shall not be exceeded. Any non-conformance with the dimensions shown shall be identified by the Supplier at the time of Tender. Any costs associated with size changes after contract award shall be borne by the Supplier. The physical dimensions shall not limit the maintainability of the switchgear. Dimensions of shipping splits shall be determined to be compliant with local shipping requirements.
- E. The supplied switchgear assemblies will be a part of a power distribution system that has multiple power sources. During maintenance and recovery operating scenarios they will be operated in a closed transition (make-before-break) mode, paralleling two of the sources. During this mode of operation, power may flow in the opposite direction due to manufacturing differences, loading and tap position of the transformers. The switchgear assemblies shall be designed to operate in this mode and optimized not to trip and disconnect during normal closed transition operation. Additionally, when backup generators are the secondary source, closed transition operation will be required between diesel-engine generator sets and the utility.
- F. The incoming cubicles (main breakers) will be connected to power transformers or MV power distribution. The design shall be coordinated to facilitate the MV connections, top and bottom entries as required.
- G. Seismic-Restraint Design. Switchgear assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces. Additional local requirements shall be for the specific project location, Specifications Section 01 81 16 Facility Environmental Data and Section 26 05 48 Vibration and Seismic Controls for Electrical Equipment, where 26 05 48 provided.
- H. The design shall include pathways to field route earthing/grounding cables from surge arresters shields and equipment to the grounding system.
- I. Nomenclature and Identification. Follow the latest revision of Specification 01 42 09 Nomenclature and Identification for document identification, labeling cabling, equipment and components. The Supplier shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation in accordance with the Owner's requirements. All information shall be provided in electronic format to be approved by the Engineer.
- J. Phase/Line Colors

	Color USA	Color IEC Regions
Phase/Line 1	Black	Brown
Phase/Line 2	Red	Black
Phase/Line 3	Blue	Grey
Neutral	White	Blue
Grounding/Earthing	Bare, green, or green- yellow	Green-yellow

- K. Reliability. As the intended use of the switchgear is to achieve the ultimate reliability of availability of power to critical loads using available power paths, it is required that each switchgear assembly does not introduce additional failure contributions that would interfere with maintenance of power to the load, as long as there are power sources available.
- L. Maintainability
  - 1. Concurrent Maintainability:
    - a. Each switchgear assembly shall be designed to be safely isolated and taken out of service for maintenance and repairs and returned to service without impacting the critical load served from this portion of the power system.
    - b. Each cubicle shall be designed to allow for safe isolation and maintenance of breaker and low voltage compartments without impacting the rest of the switchgear assembly, which should continue to operate and serve its load.
  - 2. The Supplier shall incorporate the following maintainability design concepts:
    - a. Equipment and accessories specified herein shall be designed for a life expectancy of 30 years as a minimum.
    - b. Full life cycle costs shall be considered including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified herein.
    - c. Materials shall be selected to provide corrosion- and wear-resistance protection that is adequate for the environment and service. Should a material not be replaceable with a corrosion resistant one, the susceptibility shall be mitigated with coatings as appropriate for the environment as described in this specification.
    - d. The equipment shall be able to be moved via a pallet in order to minimize the need to utilize excessive manpower or cranes for maintenance. In the event the equipment is too large or heavy to be transported via a pallet, manufacturer shall include lifting lugs and other equipment for handling bulky, heavy, and difficult to maneuver items.
    - e. Components likely to require replacement or emergency repairs shall be readily accessible and clearly marked. Such components shall be mounted in pull-out drawers and/or connected by quick disconnect fittings. Test points or terminals for maintenance shall be included. If special tools, breaker trucks or others are required for maintenance, they should be provided for each switchgear location.
    - f. Electronic components shall be protected against power fluctuations and electrical discharges.
    - g. The need to conduct periodic physical inspections shall be minimized, and equipment status and condition shall, in as far as it is practical, be remotely monitored.
    - h. Where checking of the health and status of working equipment is necessary, the Supplier shall incorporate methods of inspection compliant with applicable safety codes, Owner's requirements and that can be

accommodated without the need to power-down the equipment under inspection and / or the location from where the inspection is to be undertaken.

- i. Recalibration and cleaning requirements shall be minimized.
- j. Arc-rated windows for infrared scanning of power connections shall be provided.
- M. Interfaces shall be provided as required to connect gauges, sensors, instruments and intelligent devices to the Owner's Electrical Power Monitoring System (EPMS) for remote monitoring.
- N. The design shall account for the environmental impact due to possible breakdowns or failures and shall include measures to mitigate their impact. This shall consider equipment reliability and probability of failure, as well as economic mitigation costs.

## 1.5 INTEGRATED POWER SYSTEM

- A. The equipment supplied herein shall interface with equipment from other Suppliers to form a fully integrated, functional, resilient and concurrently maintainable power system. The Supplier shall liaise with the other equipment Suppliers to coordinate the interface with their systems, provide necessary technical information and ensure a fully integrated power system. The required interfaces include, but are not limited to:
  - 1. Diesel-Engine-Driven Generator Sets
  - 2. EPMS/PDCS
  - 3. Power transformers
  - 4. Distribution transformers
  - 5. DC Station battery system

## 1.6 SUBMITTALS

- A. General
  - 1. Languages. English, always required; and Second Language, where required. Second language specified in Specification 01 81 16 Facility Environmental Requirements.
  - 2. All drawings and data shall be identified by the Owner's project name, job location, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each drawing shall be made by such means as a triangle-enclosed revision number. Drawings shall be stamped/sealed by a registered professional engineer as required for the local jurisdiction.
  - 3. Nomenclature and Identification. Follow the latest revision of the Owner's Specification 01 42 09 Nomenclature and Identification for labeling cabling, equipment and components. The Suppliers shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation in accordance with the Owner's requirements. All information shall be provided in electronic format to be approved by the Engineer.
  - 4. CAD Standards. The Owner will provide CAD guidelines to be followed during the development of the shop drawings.
  - 5. Electronic format.
    - a. File names shall be intuitive and clearly identify the document.
    - b. All documents are required to be provided as ISO Portable Data Format (PDF) files.

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- c. Native format. The format should be the original editable format for the software product used to develop the document, drawing or model, including, but not limited to Autodesk AutoCAD; Autodesk Revit; MS Office; Keynote, Pages, Numbers, etc. Native format is mandatory for all project documents and drawings.
- d. 3D CAD drawings and Level 300 simple Revit families shall be provided for all equipment supplied.
- 6. Submittal Process. The Supplier shall upload the post-award submittals using the project Document and Construction Management System (DCMS). Sending documents via e-mail will not considered a formal submittal. The Owner may request uploading to an online file storage system such as Box as a backup or if some of the systems are not fully functional. Approval of a submittal does not warrant an acceptance of the equipment. If the requirements are not met the submittal may be rejected without review or comments.
- 7. All conflicts and discrepancies between the requirements of this Specification, Drawings, codes and standards and Purchase Order shall be referred to Engineer and the Owner for clarification before proceeding with the manufacturing of the affected parts.
- B. Prior to Bid Submittals.
  - 1. Non-Disclosure Agreement (NDA), if no NDA with Supplier on file, prior to receiving bid documents.
  - 2. Intention to Bid. Confirm intention to bid.
- C. Bid Submittal. Following the requirements herein, as a minimum, provide the information listed below in electronic format in English language through the Apple's procurement web site for OFCI and through the Contractors system for CFCI. Failure to submit this information with the bid shall cause the bid to be rejected as non-responsive.
  - 1. Commercial Offer:
    - a. For OFCI equipment:
      - 1) Signed Form of Offer/Cover Letter including total price.
      - 2) Filled in OFCI Pricing Schedule form in native format (form provided with the request for proposal), including any requested or value engineering cost options.
    - b. For CFCI equipment, follow Contractor's instructions.
  - 2. Execution and Support Plan:
    - a. Proposed Project Team.
    - b. Project delivery schedule including all major milestones.
    - c. Proposed manufacturing facility and capacity to fulfill order and meet project schedule.
    - d. Proposed local post-installation site support showing locations of support centers and response times. Include spare parts inventory and management defining the required minimum spares to be purchased by the Owner.
    - e. Quality Control and Assurance Plan.
  - 3. Technical Offer:
    - a. A narrative describing the proposed solution including any value engineering or alternative cost options.
    - b. Itemized Specification compliance response. The response shall include a copy of these Specifications, including all Appendices with each paragraph noted with the comment, "C" for Compliance, "D" for Deviation, and "E" for

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Exception. Additionally, a filled in Numbers or Excel spreadsheet shall be provided listing the paragraphs noted with deviation or exception and providing additional detail on the scope and reasons for the deviation/exception. Failure to submit this information with the bid shall cause the bid to be rejected as non-responsive. The definition of these terms appears below:

- 1) "C": By stating "compliance", the Supplier agrees to furnish the item or the feature as specified with no variation.
- 2) "D": By stating "deviation", the Supplier proposes to furnish the item or the feature in a different way, while still meeting or exceeding the intended purpose of the product. The Manufacturer shall describe the reason for the deviation and the advantages/disadvantages of the proposed solution. Deviation should clearly reference specification section and line item. Stating deviation does not mean or imply acceptance.
- 3) "E": By stating "exception", the Supplier's intention is not to furnish the item, the feature or the services specified. The Manufacturer shall describe the reason for the exception. Exemption should clearly reference specification section and line item. Stating exception does not mean or imply acceptance.
- 4) If nothing is stated, it is assumed that the Supplier states "compliance". If there are contradictions in the statements, it is assumed that the statement that favors the Owner takes precedence.
- c. Prior Project references: Provide a project listing identifying a minimum of 5 projects where you have manufactured and provided similar equipment. The listing shall include. Certain items can be excluded, if they violate non-disclosure agreements with the customer.
  - 1) Project name, location, date of project.
  - 2) Description of equipment provided including capacities, voltages, etc.
  - 3) Facility where equipment was manufactured.
  - 4) Customer contact information that must include email and phone contact information.
  - 5) Codes and Standards Compliance Statement. The Supplier shall state that their product is compliant with the codes and standards for the specific site location including local jurisdictional requirements.
- d. Type test data. Provide type test results for the governing local codes and standards. If a global product is proposed, provide type test data for both ANSI/IEEE and IEC standards. If the supplied equipment has a bespoke design for this project, provide type test data for similar equipment.
- e. Product design data, including, but not limited to:
  - 1) Data sheets providing as a minimum the parameters listed in 0 of this specification.
  - 2) Dimensions, weights, clearances and other relevant physical data.
  - 3) Single line diagrams.
- 4) Communication and network diagrams
- 5) Modes of operation and high level sequence of operation for each mode.
- 6) Control and Monitoring Systems (SCADA/PLC/ENMS/EPMS/PDCS, etc.) interface diagrams and point list.
- 7) Bill of materials.
- f. Sub-suppliers/Manufacturers of all major components.
- g. Catalog data of proposed equipment.
- h. Manufacturing:
  - 1) Manufacturing location for circuit breakers
  - 2) Final Assembly location of switchgear
- i. Preliminary Instruction Manual for Installation.
- j. Declaration of Conformity and product certifications.
- k. Reliability data for equipment and components, including MTBF, MTTR, MTTF (MTTF applies to non-repairable items only).
- I. Product recalls by category for the past 10 years.
- m. Product failures by category for the past 10 years and Root Cause Analysis (RCA) for the failures.
- n. Annual volume of equipment for the last 5 years.
- o. Product road map including maturity curves and planned product design improvements.
- p. Supporting product information necessary to understand the technical solution.
- 4. Shipping:
  - a. Proposed shipping methods and splits.
- 5. Lead-Time:
  - a. Prior-to-Fabrication Submittal sent to Owner (calendar days after contract award)
  - b. Delivery of equipment (calendar days after approval of Fabrication by Owner), for each shipment batch.
- 6. Optional equipment adders (as called out herein or as may be suggested by the Manufacturer) shall be identified on the bid submittal as to type, rating and features.
- 7. Maintenance
  - a. Recommended extra materials and spare parts, including pricing.
  - b. Maintenance schedule, including pricing for annual cost of service.
- 8. Any additional requirements from the Owner's Procurement Team
- D. Progress Reports. Starting with Award, the Supplier shall submit simple Project Progress Reports, on a monthly basis as a minimum and more frequently if required. Each report, shall contain the following, as a minimum:
  - 1. Progress during the period. Briefly describe the activities that have taken place during the period.
  - 2. Upcoming activities. Briefly describe upcoming activities and highlight action items required by the Owner, Contractor or Engineer.
  - 3. Percent complete for each part of the order.
  - 4. Project schedule status. Attach project schedule and highlight any significant changes that may impact the overall project schedule.

- 5. Project change log. Document any changes to the scope of work.
- 6. Project risks management and issues. Document any potential risks to the project including cost, schedule, quality, interface with other Suppliers and the Contractor, etc.
- E. Prior to Fabrication Submittal. Supplier's drawings and design documents shall be submitted for approval using the project Document/Construction management system within 30 days of issuance of a purchase order. The Manufacturer shall proceed with fabrication or assembly of equipment only after approval of the drawings or authorization to proceed. The Owner reserves the right to make changes in requirements until the Supplier's drawings are returned approved. The Owner may provide partial approval to facilitate procurement of long lead time components, while finalizing detailed shop drawings. Submittal shall include as a minimum:
  - 1. Bill of Materials. A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the system. Bills of material shall include all required items associated within the equipment, internal or external to the enclosure.
  - 2. Manufactured (integrated) product data sheets providing as a minimum the parameters listed in 0.
  - 3. Updated Compliance-Deviation-Exception (CDE) form listing the agreed in the contract deviations and exceptions and any additional deviations and exceptions based on the final product design in both PDF and native format. New deviations and exceptions shall be clearly identified do distinguish between the accepted with the contract ones.
  - 4. Design documents and calculations, including, but not limited to:
    - a. Design parameters and design assumptions
    - b. Control power calculation and coordination, including, but not limited to:
      - 1) Maximum peak load (Amps) during switching of all circuit breakers
      - 2) Normal steady state (Amps) during normal operation
      - 3) Normal steady state load of all equipment / items within the assembly
      - 4) Maximum load of the circuit breaker spring charging motor
    - c. Paint system and methods of painting
    - d. Foundation and pad requirements
  - 5. Shop drawings, including the following items as a minimum:
    - a. Plans, elevations, sections and details showing dimensions, minimum clearances, door swings, entry provisions for field connections, height to terminal connections, gutter space, installation anchoring points, identifying and listing installed features and devices, weights, center of gravity, lifting and handling provisions and requirements, for each assembly specified.
    - b. Seismic and anchoring details.
    - c. Nameplates and mimic diagrams
    - d. Power cable size, cable glands and termination drawings for field connections.
    - e. Single line and three-line diagrams.
    - f. Controls, monitoring and protection diagrams, including fan control.
    - g. Communication and network diagrams.
    - h. Control power and auxiliary power diagrams.
    - i. Control and network wiring termination drawings for field connections.
    - j. Control and auxiliary power wiring termination drawings for field connections.

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- k. Process and instrumentation diagrams (P&ID) showing locations of switchgear supervision instruments and sensors.
- 6. Product data sheets for each component. Include model numbers, data on features, components, ratings, and performance. For current transformers include class and saturation curves.
- 7. Material safety data sheets.
- 8. Circuit breaker, trip units, fuses, protective relays and devices data, including model number, interrupting ratings and time-current curves.
- 9. Interface to Owner's Monitoring and Control Systems:
  - a. Point lists and communication registers for interface.
  - b. Configuration files and required programming
- 10. Written description of key interlocking and/or switching sequences, where applicable.
- 11. Factory and site acceptance test procedures. Submitted procedures shall be detailed and project specific.
- 12. Shipping plans
  - a. Parts shipped disassembled and separate
  - b. Route and logistics
- 13. Instructions and Manuals.
  - a. Specifications for the method of placing and anchoring the equipment to the structural members, including an indication of the highest UBC Seismic Zone for which anchorage method is rated.
  - b. Installation Instructions.
  - c. Preliminary Operation and Maintenance Manuals.
- F. Prior to Installation Submittals. Installation, Operation and Maintenance Instructions and Manuals, relevant fabrication drawings, settings and calibration records shall be submitted by the Manufacturer using the project Document/Construction management system when required by the Contractor and the construction schedule, but no later than 30 days prior to initial shipment. As a minimum the following items shall be provided:
  - 1. Updated shipping plans.
  - 2. All information required for handling; installation; connecting of power, control and network wiring; start up and commissioning; maintenance; and operation of the supplied equipment.
  - 3. Updated to "As fabricated" state shop drawing and other relevant information from Prior to Fabrication Submittal.
  - 4. A detailed description of the modes of operation and sequence of operation for each mode including trapped key interlocking and/or switching sequences, where applicable.
  - 5. Intelligent Devices and Relays
    - a. Firmware revision
    - b. Factory configuration and settings in both native format and PDF.
    - c. Configuration/programming instructions and software for each type of relay/device.
  - 6. Test reports and calibration records
    - a. Factory un-witnessed and witnessed test reports
    - b. Calibration and test records for instrument transformers, devices and instrumentation together with calibration instructions and software for each type of device.
    - c. Supporting photographs for the following viewpoints: overall outside; detailed outside; compartments; nameplates, etc.

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- 7. Preventive maintenance schedule with detailed instructions and procedures for each maintenance activity.
- G. Prior to Final Acceptance Submittals. Compliant with specification Section 017823 Operations and Maintenance Data, after commissioning and prior to taking over, as a minimum, the following items shall be submitted by the Supplier using the project Document/Construction management system when required by the Contractor and the construction schedule, but no later than 30 days after commissioning of the equipment.
  - 1. Updated to "As built" state drawings and documents provided under Prior to Installation Submittal.
  - 2. Updated and final Installation, Operation and Maintenance instructions provided under Prior to Installation Submittal.
  - 3. Copies of completed factory and site testing reports including records of final settings and calibration.
  - 4. Equipment warranties and contact information for warranty matters.
  - 5. Final Compliance-Deviation-Exception (CDE) form listing the agreed in the contract deviations and exceptions and any additional deviations and exceptions based on the "as built" condition in both PDF and native format. Deviations and/or exceptions shall clearly reference specification section and line item.
  - 6. For all intelligent Devices, including, but not limited to: protective relays, power meters, controllers, sequence of event recorders, managed switches, gateways, etc., provide:
    - a. Latest firmware revisions downloaded to the devices with a revision control system including a device list and the latest firmware version.
    - b. Configuration software, three (3) perpetual licenses as a minimum.
    - c. Configuration files in native format.
- H. Requests for Information (RFIs). If the Supplier needs to clarify the design intent or discrepancies within the documentation, RFIs can be submitted through the Project Document/Construction Management System. RFIs shall not be used to propose alternative design solutions or for Change Orders. Each RFI shall clearly identify the Drawing or specification number, revision, date, section number and page relating to the clarity. A separate RFI shall be raised for each clarity.

### 1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
  - 1. The Manufacturer shall be a firm specialized in manufacturing the equipment specified herein, with minimum of ten years of documented experience and five projects of similar size.
  - 2. The Supplier shall have an authorized service center in the region capable of providing training, parts, and emergency maintenance repairs within a response period of less than twenty-four (24) hours from time of notification.
- B. The Supplier shall establish and maintain procedures for:
  - 1. Qualification/certification of field service specialists and technicians.
  - 2. Escalation of field service problems to Manufacturer's engineering support when required to back up field service personnel.
  - 3. Document and provide firmware, configuration and application software version control for the supplied intelligent devices.
  - 4. Spare parts inventory control.
  - 5. Customer notification of Manufacturer's equipment upgrades and product service alert bulletins.

- C. Supervising Specialist Qualifications
  - 1. The specialist shall be certified and authorized by the Manufacturer to supervise and direct installation of the supplied equipment.
  - 2. The specialist shall be familiar with the equipment, Manufacturer's installation instructions and applicable safety requirements.
- D. Testing Specialist Qualifications.
  - 1. The specialist shall be certified and authorized by the Manufacturer to perform testing, start up and commissioning of the supplied equipment.
  - 2. The specialist shall be familiar with the equipment, the instruction manuals and test procedure.
  - 3. The specialist shall have the required certifications and have experience in testing of installations of similar size and with similar components used. The experience shall include MV switchgear, protective relay testing, power quality metering, etc.
- E. Conformity and compliance. Electrical components, devices, accessories and cables shall be certified, listed and marked as follows:
  - 1. USA: Where applicable, certification from Nationally Recognized Testing Laboratory (NRTL).
- F. Regulatory Requirements. Shall comply with the codes and standards listed under Paragraph 1.2 and requirements of the local code authority having jurisdiction.
- G. Prototype and Mock-up:
  - 1. After approval of the design the Manufacturer shall fabricate the first assembly as a prototype. The Supplier shall demonstrate on the fully functional assembly the ability to meet all the requirements of this and any complementary specifications.
  - 2. Any design modifications resulting from the prototype manufacturing and testing shall be retrofitted on the prototype assembly and adopted for manufacturing of subsequent assemblies.
- H. The Supplier shall participate in coordination meetings to ensure understanding of functional and installation requirements impacting the design and coordinate project sequencing and scheduling.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. For non-standard shipping dimensions and weights, the Supplier shall perform logistics analysis, survey shipping routes and site access to ensure safe and on time delivery to the project site. The Supplier shall be responsible for compliance with local trucking and delivery laws and requirements.
- B. Identify shipment with Company's purchase order number, Owner project name, and unit/tag number, following the project naming convention.
- C. Ship all equipment properly packed in tightly sealed, heavy gauge plastic or other type of liquid proof cover to protect the equipment from handling, shock, vibration, corrosion, rain, dust, and other foreign material.
- D. Sensitive to the environment equipment shipped separately or as a part of a bigger assembly shall be sealed and protected for any physical or environmental degradation or damage during shipping and storage.
- E. Equip all shipments and packaging with GPS tracking and recording devices and digital three-axis shock and vibration data loggers that are armed prior to lifting for transportation. In the event that the equipment is found to have been subjected to

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- F. When assemblies are supplied that require disassembly for installation or are shipped disassembled, each piece of the subassembly so affected will be uniquely identified as to its assembly position.
- G. Box, crate or otherwise completely enclose and protect any loose components and spare parts. Clearly mark all equipment and provide complete installation instructions for any parts shipped separately from the main assembly.
- H. Adequately brace each shipping unit and its components, both internally and externally to prevent damage during shipping, handling, storage or in the process of erection.
- I. Clearly mark all shipping blocks, binding, braces, supports, etc. so that removal is assured. Identify any special precautions that must be observed when removing shipping constraints.
- J. Provide all shipping units with provisions for lifting and or skidding into place. Clearly mark all lifting points.
- K. Furnish unique installation materials and tools where required for the installation and commissioning of the equipment.
- L. Ship equipment by air ride truck via direct dedicated carrier to job site. Coordinate the delivery with the Contractor and the Installing contractor with proper notifications for status of delivery. Installing contractor will be responsible for unloading and placing equipment at its final location under the Manufacturer's supervision.
- M. The Supplier shall be responsible for the repair or replacement at their expense of all damage due to improper preparation, packing or damage while in transport.
- N. The Contractor shall be responsible for receiving, inspecting and storing the equipment until installation. The specified equipment shall be kept dry and clean at all times. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

#### 1.9 SITE CONDITIONS

A. The supplied equipment and systems shall be designed for the site conditions. See Specification 01 81 16 Facility Environmental Requirements for site data and environmental conditions.

#### 1.10 SEQUENCING AND SCHEDULING

- A. The Supplier shall be responsible to coordinate production, testing and delivery schedule with the Contractor, Engineer, Commissioning Authority and the Owner to ensure ontime delivery of the equipment coordinated with the project construction schedule. The Supplier shall provide regular schedule updates and notifications for potential schedule delays.
- B. The Contractor shall provide up to date project schedules to the Supplier on a regular basis and on a monthly basis as a minimum.

#### 1.11 WARRANTY

A. Warranty the specified equipment and all other associated equipment (excluding batteries) as specified herein to be free from defects in materials, workmanship and non-

performance per the requirements of this Specification for a minimum of 3 years after written acceptance by the Owner. If any defects are discovered by the Owner or its representatives within the Warranty period, the Manufacturer shall repair or replace, at Owner's option, defective products at no cost to the Owner.

- B. If the equipment fails to meet the specific performance guarantees, the Supplier shall recommend to the Owner adjustments or modification. Upon approval by the Owner, the adjustments or modifications shall be made, and tests shall be rerun. The cost of these adjustments or modifications and complete re-testing shall be made at the Supplier's expense. After such adjustments or modifications, should the equipment fail to achieve the guaranteed performance, an equitable settlement shall be made which may, without limitation, include an adjustment of the contract price.
- C. Furnish warranty covering all costs for removal, repair, retrofit, reinstallation, parts, hardware and software upgrades, complete re-testing, testing equipment, associated freight charges, service engineering charges, labor, travel, and living expenses for the manufacturer's service personnel. Performance of warranty work shall not be restricted to normal working hours but shall be at the Owners choosing including overtime and weekend hours at no additional cost to the Owner. The Warranty for the repaired or replaced equipment shall be extended for one year from the completion of repairs or replacement.
- D. Complete re-testing, as referred to in this section shall mean site acceptance testing as stipulated in testing portions of this specification including commissioning activities. The conditions that apply to original testing requirements shall also apply to the re-testing of any equipment performed under the conditions of this guarantee. The cost of this re-testing shall be made at the Supplier's expense.
- E. Service Response Time required to provide service on a 24-hour, seven days a week basis by a factory trained field service engineer with:
  - 1. Phone Support within 15 minutes of initial call by Owner or owner's representatives
  - 2. On-site support within 4 hours of initial call by Owner or owner's representatives
  - 3. Be fully capable of providing high-quality, factory-trained service personnel and Manufacturer-certified replacement parts.
  - 4. All service reports shall be provided to the local site facilities engineer within 1 week of any site visit.
- F. Replacement parts shall be compatible with the equipment. If the original part is not available or is superseded by a newer model, approval by the Owner is required for the substitute part.
- G. The name, address, e-mail, website and twenty-four (24) hour telephone number of the nearest authorized service organization shall be displayed on the inside of the door of each enclosure and also provided with the maintenance manuals.
- H. The Supplier shall establish, maintain and follow procedures for:
  - 1. Qualification/certification of field service technicians.
  - 2. Escalation of field service problems to Engineering and R&D departments.
  - 3. Spare parts inventory control, availability and end of support.
  - 4. Software and firmware version control and notifications for critical updates
  - 5. Customer notification of Manufacturer's equipment upgrades and product service alert bulletins.

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### 1.12 SYSTEM TESTING, START UP AND COMMISSIONING

- A. Type Tests. The Supplier shall be responsible for type testing as required by the governing standards. Type test reports shall be provided for review.
- B. Level 1 Fabrication
  - 1. Level 1x Factory Prototype Test. If required in paragraph 2.17 of this specification a prototype test for selected switchgear assemblies shall be performed as a "proof of concept" and to validate the design.
  - 2. Level 1y Third Party Laboratory Test. Not required for the specified equipment, contingent to verification of type test reports.
  - 3. Level 1a Factory Acceptance Test (FAT)/ Factory Witnessed Test (FWT) for Switchgear Assemblies
    - a. The Supplier shall perform routine and any additional tests specified herein and required to ensure that the equipment conforms to codes, standards and Owner's equipment specification. The testing shall encompass any thirdparty equipment integrated into the product and supplied by the Owner or the Supplier.
    - b. The Owner and/or its representatives, the Engineer and the Commissioning Agent will witness in person the final factory acceptance test for selected or all assemblies. All equipment shall be pretested prior to the arrival of the Owner and applicable reports provided. The scope of the FWT shall be coordinated to avoid repetition of destructive testing and minimize wear and tear on equipment. The Owner may request performing some of the type tests, if design significantly different than the equipment listed in the type test reports. Equipment shall be scheduled on the factory floor, prepared and pretested to minimize any idle time.
  - 4. Level 1b FAT/FWT for Integration
    - a. Interfaces for the integration into other systems including FacNet, EPMS and PDCS, shall be tested and verified. Where integration into PDCS specified, equipment shall be tested together with the PDCS equipment and supplier
    - b. FWT for integration shall be coordinated and consolidated with Level 1a to minimize travel and additional trips for the Owner/Engineer/CxA/GC.
- C. Level 2 Equipment Installation
  - 1. The General Contractor (GC) shall have processes and perform verifications to ensure the equipment is received, stored, installed and made ready for testing.
  - 2. The GC shall employ a testing agency to perform tests conforming to ANSI/NETA ATS requirements and any additional pre-energization tests.
- D. Level 3 Supplier Startup the equipment Supplier shall have procedures and methods and perform testing to ensure the equipment is started, adjusted and performance is validated on site.
- E. Level 4 Equipment Specific Commissioning The Supplier, GC and Owner CxA shall coordinate the validation of the installed equipment. The CxA shall direct the commissioning test with the assistance and support of the GC and the Supplier.
- F. Level 5 Integrated System Testing The Owner CxA shall develop tests that ensure multiple systems, subsystems and components work as integrated systems. The GC and Supplier(s) shall assist and support these tests.
- G. The Owner CxA will review test reports, partially or completely witness tests performed by other entities and validate completion of the required of each level tests and

verifications. The GC and Supplier cannot proceed with the next level without authorization/tagging of the pertinent equipment.

### 1.13 MAINTENANCE

- A. Extra Materials and Spare Parts
  - 1. Manufacturer to develop list of recommended extra materials and spare parts. List to include per unit pricing.
- B. Maintenance Service
  - 1. Manufacturer to develop recommended maintenance schedule and procedure with detailed instructions. Include optional pricing for annual cost of service.

### PART 2 - PRODUCTS

### 2.1 GENERAL

A. This section defines the general requirements for the products. See Appendices for specific project-based product rating requirements. Other appendices may be provided with sketches and schematics clarifying the requirements. The appendices and drawings are an integral part to this specification and shall be considered as such.

### 2.2 SWITCHGEAR ASSEMBLY

- A. The Switchgear shall be formed from individual, free standing, vertical sections, each having segregated compartments including: a main busbar compartment isolated from the breaker; a breaker compartment with a truck for breaker removal (draw-out); a cable compartment; voltage/potential transformer compartment; and low voltage control and instrumentation compartment. Compartments shall be segregated by grounded steel barriers. Sections shall be bolted together to form a rigid metal clad switchgear assembly.
- B. The Switchgear shall be manufactured with framework formed of steel. Bracing, reinforcing gussets and jig welding shall be used to assure rectangular-rigidity. Steel foundation channels and bottom plates with conduit entrance covers shall support the gear for direct mounting on the concrete foundation pad. Perimeter channels shall be suitable for welding to iron embeds in the support pads. Minimum steel thickness shall be as specified in 0.
- C. Where the switchgear is installed over a trench or a vault the Supplier shall provide and install the switchgear steel frame for the switchgear. The switchgear steel frame shall be in line with the ground slab. The switchgear steel frame shall be bolted to the ground slab and concrete side walls. The switchgear shall be bolted to the steel frame. All bottom entry switchboard shall be installed over a trench. The switchgear steel frame shall be suitably constructed to support the switchgear
- D. Arc-flash Protection. The following features shall be provided as a minimum:
  - 1. Arc flash monitoring: Provide all SEL-751 protection relays with fiber-optic based arc sensing cables in both the MV cable termination compartments, main bus section and in the breaker compartment (for rack-in/out protection). Couple relay AF sensing with overcurrent 50P element to eliminate inadvertent tripping due to a bright light source only. Any arc-flash or bus differential event shall trigger 86 lock-out relay and trip all upstream incoming sources.
  - 2. Arc Flash Protection covers / screens shall be provided around the withdrawal circuit breakers during racking in and out.

- 3. Arc Flash Labels. The Engineer of Record or a Specialty Consultant will perform an Arc-Flash Hazard Study for each switchgear assembly. Arc-Flash Labels will be affixed to the switchgear assemblies based on the results of the study.
- E. Provide metal barrier in front of, or a part of, the circuit interrupting device to ensure that, when in the connected (operating) position, no primary circuits are exposed by the opening of the circuit interrupting device's compartment door.
- F. All doors and covers providing access to high-voltage components shall have proper latches and mechanical interlocks to avoid operation of breakers when opened or opening when relevant breakers in operational position and closed. The doors, hinges and covers shall be constructed to contain the pressures of an internal fault arc, and maintain the arc containing integrity of the Switchgear in accordance with the specified rating.
- G. All hinged components shall have at least 1-inch/25.4mm clearance above the bottom of the Switchgear to provide clearance to floor or pad surface.
- H. All doors shall be solidly grounded to the metal of the switchgear assembly by means of a flexible grounding strap of braided copper.
- I. Metal barriers shall be provided between primary circuits in cable pull-sections, or bustransition sections.
- J. The front and rear base of each end cubicle of the switchgear assembly shall contain two tin plated standard-pattern drilled and tapped grounding pads welded to the structure to permit bolting of ground/earthing lead terminals from the subsurface grid. A copper ground/earthing bar shall extend through all switchgear sections to provide secure bonding of all structural and apparatus enclosures to the incoming utility neutral and the subterranean ground grid system. The bar shall be sized in accordance to local codes and standards and validated by a type test.
- K. Each bussed section shall include infrared ports to enable thermographic inspection of incoming and outgoing electrical connections and lug landings. The complete window unit shall be permanently fitted into the Switchgear and shall provide both visual inspection and thermal imaging on fully energized electrical equipment through closed doors. Windows shall be mounted at appropriate height and shall be code compliant and not compromise the internal arc classification and arc-resistance rating of the assembly.
- L. Anti-condensation Space Heaters. Anti-condensation space heaters shall be provided for switchgear located outdoors or in metal enclosures. Space heaters shall not be required for switchgear located in buildings with air-conditioned electrical rooms. The space heaters shall have perforated metal guards shall be provided in all sections of the equipment (one in the rear cable area, and the other in the front compartment). Space heaters shall be applied at 50 percent rated voltage to extend operating life. Minimum output at applied voltage shall be 250 watts per Switchgear section. The heaters shall be thermostatically-controlled, and monitored by current relays. Contacts from the relays shall be wired by the Manufacturer to the sequence of events recorders in each array, to alarm any space heater failure to the Owner's EPMS/PDCS systems. The Switchgear heaters in each array shall be balanced on two AC branch circuits from the distribution panel to provide service continuity to one half the heaters if heater failure trips either branch breaker.
- M. All openings in the sidewalls or the base frame of the equipment shall be screened or plugged to prevent entry of rodents, birds or reptiles.

- N. All hardware shall be captive with no loose components.
- O. Non-ferrous materials shall be used for brackets and other supports where current carrying conductors and busses can cause inductive heating.
- P. Finishes
  - 1. All steel parts shall be thoroughly cleaned, degreased and phosphatized by being passed through a hot phosphate chemical bath and rinse. After completely drying, the metal shall be uniformly coated with a polyester-base, urethane, or acrylic paint material. Thickness shall be uniform, and shall comply with recommendations of the paint manufacturer to minimize "orange peel" and to prevent chipping, bleed-through, and rusting. In general, paint thickness shall be not less than 50 microns (2 mils) on any metal surface. After coating, the paint shall be cured as specified by the paint manufacturer. Color shall be as specified in 0. For outdoor equipment, the minimum solar reflectivity of 74% and 30 year warranty covering cracking, fading and chalking.
  - 2. All enclosure base structural members shall have a factory applied bitumastic based undercoating sprayed or brushed on all metallic surfaces to an elevation of 4 inches above the proposed concrete foundation pad.
- Q. Assemblies shall have front and rear access.
- R. Provide fully equipped spaces for future and spare circuit breakers shown on the Drawings, complete with relays, current transformers, control devices, and all internal wiring connected to field wiring terminal boards to permit future installation of circuit breakers with a minimum of work required in the switchgear cubicles.

#### 2.3 BUSBAR COMPARTMENT AND BUSBAR ASSEMBLY

- A. Each main busbar compartment shall contain a bus assembly rated as shown on drawings and in 0, 3-phase, 3-wire, fabricated from electrical grade round edge copper bar and silver plated at all joints and splices. The busbar shall be designed and sized so no opening is required to maintain rated temperature.
- B. Connections. Bus connections and splices shall be made using Metric Grade 8.8 (SAE Grade 5) or better plated hardware, employing flat and spring-type lock washers at each bolted connection.
- C. Insulation. The busbar shall be insulated along its length with anti-tracking, flameretardant insulation TE Connectivity (Raychem) BPTM or approved equal. All joints and splices shall be covered by pre-formed molded boots, attached with nylon fasteners.
- D. The busbar assembly shall be supported in its structure by electrical grade insulators, and inserts shall be supplied to insulate the openings where the bus assembly will passthrough sidewalls to adjacent sections or cables will pass through sheet steel barriers. All bus support insulators shall be epoxy resin with a leakage distance commensurate with the maximum voltage and basic impulse levels listed above. Insulators made by ferrous materials are not acceptable.
- E. Ferrous materials are not acceptable
- F. The bus compartment shall have removable back covers to provide accessibility. The bus compartment shall be designed to permit future extension of the bus and maintenance.

## 2.4 CIRCUIT BREAKER COMPARTMENT

- A. The compartment shall house removable circuit breaker elements and include primary and secondary disconnecting contacts. The stationary primary disconnecting contacts shall be electroplated copper and recessed within insulated supports. Automatic safety shutters shall cover the stationary primary disconnecting contacts when the breaker element is withdrawn from the connected position. The shutters shall be mechanically driven during withdrawal to ensure safe and reliable operation. Gravity based operation of shutters is not acceptable.
- B. The compartment shall have sufficient clearance from the bottom of the assembly to allow for proper operation and replacement of breakers.
- C. The compartment shall be equipped with manually-operated, screw-type draw-out racking mechanism and automatic service shutter. The compartments shall be sized with sufficient clearance to allow the breaker to be in the drawn-out position with its door closed.
- D. A TOC switch shall be provided in each circuit breaker compartment to indicate when the breaker is in the connected position.
- E. Provide position labels in each compartment clearly indicating the circuit breaker's "CONNECTED" and "DISCONNECTED" position.
- F. The compartment front door shall be capable of being safely opened to provide full access to the front of the circuit breaker control faceplate. A viewing window shall be incorporated into the door to allow visibility of the breaker faceplate controls with the door closed and latched.
- G. Each compartment and circuit breaker shall be provided with mechanical interlocks to prevent the insertion of a circuit breaker into the compartment with a higher frame size or interrupting rating.
- H. Breaker control and indication shall be from the associated protective relays. No hardwired control switches or indicating lights are required.
- I. One control circuit cutout device shall be provided and installed in the control compartment of each circuit breaker for control circuit isolation and short circuit protection. These circuits shall be monitored and alarmed for loss of power.
- J. Provide means of padlocking the racking mechanisms in fully withdrawn position.
- K. Remote Racking and Operation System. The circuit breaker compartment and breakers shall be capable of accepting industry standard devices for remote racking and remote in-room (non-SCADA/EPMS/PDCS) operation.

### 2.5 MV CABLE COMPARTMENT

- A. The Supplier shall make allowances for the cable types, cable sizes and number of cables to be connected to each of the MV cubicles as shown on the drawings or in cable reports, including all required bus, landing stubs, stand-off insulators and supports for receiving the incoming and outgoing medium voltage cables.
- B. Cable compartments shall be designed for clear, unobstructed access to line and load lug locations, with lug landings at sufficient height and with sufficient working space to allow pulling cables and easy installation of single conductor heat shrink cable terminations. Removable cross members shall be provided by the manufacturer, suitable for supporting cables within the cable area to eliminate excessive strain on the bus

MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR

assembly or on the cables themselves. All line and load lug landings shall be furnished with standard hole patterns, to accept 2-hole hydraulic long barrel compression lugs.

- C. Cable compartments shall be designed to accommodate the required number of Current Transformers (CTs) including zero sequence CTs (where required) directly above or below the primary cable terminals, so the primary cable or cables can pass through them. Installing CT's below bottom of Switchgear is not acceptable.
- D. Cable compartments shall be designed to accommodate the required Surge Arresters.
- E. Cable compartments shall be designed to accommodate the required Potential/Voltage Transformers, where no separate compartment available.
- F. Cable compartments shall be designed to accommodate Earthing/Grounding switches.
- G. Cable compartments shall have ground bars connected to the grounding system to support armor/shield terminations.

#### 2.6 LOW VOLTAGE COMPARTMENT

- A. All low voltage protection, control and instrumentation devices shall be located in a separate low-voltage, non-arc containing compartment above the breaker section.
- B. Provide terminal strips in these compartments for interface with control cabinets.

### 2.7 CIRCUIT BREAKERS

- A. All circuit breakers shall be vacuum type in metal-enclosed, horizontal draw-out assemblies. The ratings for each circuit breaker shall be as shown on the drawings and in 0. All circuit breakers identified as "spare" on the drawings shall be fully fitted out as part of this package and furnished by the Supplier. Breaker ratings shall be in accordance with ANSI/IEEE and IEC standards and type tested to these standards.
- B. Each breaker shall be fitted with the following options as a minimum:
  - 1. Spring charging motor with an emergency manual handle or magnetic actuator with manual trip handle
  - 2. Shunt opening release
  - 3. Second shunt opening release
  - 4. Shunt closing release
  - 5. Truck blocking magnet
  - 6. Operation counter
  - 7. "CLOSE/ON" and "OPEN/OFF" push buttons located on the front of the circuit breaker for opening and closing the breaker manually.
  - 8. Auxiliary position contacts: "a" and "b", five (5) of each type.
  - 9. Operating mechanism status contact
  - 10. Circuit breaker close and trip circuits monitoring with the circuit breaker in both the open and closed positions and alarm if the trip circuit opens or the power supply fails. Coil monitoring shall be accomplished via the protective relays provided for that service. Also, lockout relay coils, where provided, shall be monitored in a manner similar to the circuit breaker close and trip circuits.
- C. Circuit Breaker Operation
  - 1. Position 1, Connected: the circuit breaker shall be in the normal operating inside the compartment, with safety shutters fully opened and primary & secondary connections fully connected. Provide a label or other marking, visible both on the door and floor when the door is open indicating the breaker is fully connected.

26 13 13

2. Position2, Disconnected: No primary high voltage connections shall be connected and the safety shutter are automatically closed over the stationary high voltage contacts in the compartment. While in the disconnected position it shall be possible to connect the secondary connections of the breaker and test its operation electrically or manually. Provide a label or other marking, visible both on the door and floor when the door is open indicating the breaker is fully disconnected.

### 2.8 INSTRUMENT TRANSFORMERS

- A. Instrument transformers and surge arresters shall be provided as indicated on the Drawings and as required for a safe and reliable protection and metering system. Dimensions shall be coordinated with cables.
- B. Voltage/Potential Transformers (VT or PT):
  - 1. The PT's shall be provided with three silver-sand current-limiting fuses on the primary side and shall be mounted in draw-out assemblies with automatic service shutters that positively cover primary circuit elements when the PT tray is moved to disconnect/test position. The shutters shall be mechanically driven during withdrawal to ensure safe and reliable operation. Gravity based operation of shutters is not acceptable.
  - 2. The fused draw-out assemblies shall include a set of sliding earthing/ground stabs, arranged for "make-first, break-last" operation that allows the ground to be established prior to the power connections being made, and the ground is maintained until after the power connections are broken.
  - 3. Transformers shall be connected Wye-Wye with grounded neutral points. PT's shall be rated phase-to-phase voltage on the primary and secondary and operate at phase-to-ground voltage on the primary and the secondary to reduce electrical stress within the PT coils. Transformers shall be suitable for Owner's metering use as well as protective relays. Potential transformers shall have an insulation level equal to the switchgear BIL as scheduled herein.
  - 4. The PTs shall be provided with secondary fuses or circuit breaker.
- C. Toroidal core type Current Transformers (CTs) shall be furnished as required for protective relays and metering. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers.
  - 1. CT's shall have accuracy rating adequate for the type of relay/meter burden connected to each CT.
  - 2. Separate CT's shall be provided where show for metering with accuracy as specified in 0.
  - 3. CT wiring shall be multi-conductor cable with color coded insulation on the incorporated wires. Each phase wire and the common (neutral) wire shall be a different color, and phase/neutral colors shall be consistent throughout the entire project.

	Color ICEA Method 1,		
	Table E1		
Phase/Line 1	Black		
Phase/Line 2	White		
Phase/Line 3	Red		
Neutral	Green		

4. The secondaries of all current transformers shall be wired to Shorting/Test terminal blocks. CT terminal blocks shall be labeled with CT polarity. Each CT and its

shorting block shall have a unique name. The unique CT/shorting block name shall appear on the submittal and as-built drawings.

- 5. Ground connections shall be made at shorting terminal blocks.
- 6. CTs shall have proper dimensions to accommodate cables.
- 7. CT's shall be supported to be perpendicular to MV cable where shown not mounted on mv breaker runbacks..
- 8. Protection CT's shall be located on the MV cables, where shown, or on line-side runback stabs of the associated circuit breaker to ensure tripping due to overcurrent condition in addition to arc-flash event.

### 2.9 SURGE ARRESTERS

A. Surge arresters shall be provided at each cable termination and each PT. Arresters shall be intermediate class, gapless, metal oxide disk type, and shall comply in all respects with relevant code requirements. Basic arrester rating shall be as scheduled herein for the voltage class of the Switchgear, with a maximum continuous overvoltage (MCOV) rating at least 130% of the nominal phase-to-ground voltage. The arresters shall be mounted within the equipment's arc containing space in such a manner as to not obstruct the load cable termination area in the breaker compartment.

### 2.10 CONTROL POWER AND AUXILIARY POWER

- A. Control Power. Each switchgear assembly shall accept two independent power supplies to serve control, protection and indication devices and breaker charging and truck motors. The type of power shall be as specified in 0 with details on the station battery system provided in specification Section "26 33 23 Central Battery System".
  - 1. The Supplier shall provide load calculations and number of circuits for each assembly to facilitate the sizing of batteries and feeder circuits.
  - 2. Coordinated fusible elements shall be provided to each tap-off connection to avoid tripping of upstream devices on a local fault, including but not limited to trip and close circuits and protective relays. Where the power bus crosses a fire break, the bus shall be fused.
  - 3. For devices with a single power input, source selection device shall be used to maintain high power resiliency.
  - 4. If protection and control devices can be powered from the switchgear main power system, the switchgear shall be designed in a way that allows these devices to accept power from the Control Power system either as main power source or as a backup power source to enable metering and visibility during a main power outage or maintenance. Power converters may be used if devices use supply power that is different than the control power.
- B. Auxiliary Power. Each switchgear assembly shall accept one power supply to serve nonessential lighting, heating and auxiliary loads. The type of power shall be as specified in 0. The Supplier shall provide load calculations for each assembly to facilitate the sizing of feeder circuits. Each local circuit shall be protected and coordinated to avoid tripping of upstream devices on a local fault.

### 2.11 PROTECTION AND INTERLOCKING

A. The Supplier shall design and furnish a fully functional protection system, including, but not limited to: protective relays, interlocking circuits, instrument transformers, cabling between the ends of differential protection schemes and other required appurtenances

as described herein and shown on drawings. Relay settings shall be provided to the Supplier by the Engineer or a Specialty Consultant.

- B. The Supplier and the Contractor are required to liaise in order to ensure that adequate cable containment is provided for the connections.
- C. Protective Relays. Latest model of microprocessor-based protective relays from Schweitzer Engineering Labs (SEL) shall be used. Relays to include Sequence of Event Recording and networking for connection to the Owner's Facility Network.
  - 1. Mounting: Semi-flush.
  - 2. Functions: As indicated on the Drawings and specified in the protection functionality paragraph below (2.11F).
  - 3. Utility grade IEEE C37.90.
  - 4. Protective relays shall be provided with drawout construction or test switches to facilitate testing, maintenance and replacement.
  - 5. Test switches or test blocks shall be provided in each current, potential circuit and trip circuit.
- D. Setting Groups. Provide capability to reduce protective settings to a "Safe Mode" that minimizes arc flash potential for use by maintenance personnel when working around energized equipment. Safe Mode setting groups shall be selectable from a front panel key operated switch. Selecting Safe Mode will also activate a blue flashing light on the front of the switchgear and initiate an alarm in the PLC.
- E. Test Switch Blocks. Provide fail-safe test switch blocks for isolating protective relays during testing. Test terminal blocks shall incorporate plug-in style modules (handles) that allow for the connection of relay testing and load simulation devices to the relays while the switchgear is still under load and plug-in shortening modules for spare CT cores. Provide nameplates indicating each pole use.
  - 1. Base and cover constructed of polycarbonate insulating material.
  - 2. Semi-flush, through panel mounting with screw or stud type terminal connections on rear of switches separated by polycarbonate barriers.
  - 3. Individual switches:
    - a. Ratings: 600 V, 30 amp.
    - b. Knife blade type separated by insulated barriers.
    - c. Phenolic insulated handle with provisions for identification cards.
    - d. Provisions for horizontal interlocking bar.
    - e. Types:
      - 1) Potential (transformer) non-shorting.
      - 2) Current (transformer) non-shorting with test jack.
      - 3) Current (transformer) shorting, make-before-break.
    - f. Test plugs:
      - 1) Provide one separate source test plug for each switchgear lineup.
      - 2) Provide one series test plug for each different test switch configuration for each switchgear lineup.
- F. Protection Functionality. Provide protection functions as shown on the drawings and the following functionality as a minimum:
  - 1. Ts Switchgear Incoming Normal PowerFeeders. (SEL-351S7)

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Non-directional	50/51	3 >, 3 >>,	PIOC	
Overcurrent		3 >>>	PTOC	
(Instantaneous				
and Time)				
Non-directional	50N/51N	<sub>0</sub> >,   <sub>0</sub> >>,   <sub>0</sub> >>>	PIOC	
Earth/Ground			PTOC	
Fault				
Negative	46	<sub>2</sub> >	PPBR	
sequence or				
phase-balance				
current				
AC Directional	67PGQ	←>	PDOC	Utility and
Overcurrent				Generator
(Phase/Ground/				System
Negative				incoming
Sequence)				feeders only
Undervoltage	2/	30<	PIUV	No lockout
Overvoltage	59	30>	PIOV	No lockout
Voltage or	60		PACR	No lockout
Current Balance				
(LOSS OF				
Potential)	47	11.5		
Phase-sequence	47	$0_{2}>$	PPBV	
or phase-balance				
	9111	fz		Only for
Under frequency	010		FIUF	incoming utility
				feeders no
				lockout
Over frequency	810	f>	PTOF	Only for
e voi nequeney				incoming utility
				feeders, no
				lockout
Directional	32R	P←> or -P>	PDOP	Only for
(reverse) Power				incoming utility
				feeders when
				backup
				generation
				system
				connected to
				the switchgear
				assembly
Synchronism	25		RSYN	Permissive for
Check				closed
				transition, no
				lockout
			0005	
Breaker Failure	50BF	3I>/Io>BF	KBRF	

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Circuit Breaker		TCS	SCBR	For both trip
Trip Circuit				coils for each
Supervision				breaker. Alarm
Desta stice Delay				only
Protective Relay				Fall-sate
Fallure				internal relay
				failure or loss
				of control
				power trips the
				associated
				breaker(s)
Lockout	86		PTRC	Breaker
			XCBR	Reclosure
				Lockout for the
				associated
				breaker
Breaker Wear				breaker
Monitoring				
2. Non-transfor	mer Load Feeders	(SEL-751)		
Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Non-directional	50/51	3 >, 3 >>,	PIOC	
Overcurrent		3 >>>	PTOC	
Non directional	50N/51N		PIOC	
Farth/Ground	50IN/5 IIN	10-, 10, 10	PTOC	
Fault			1100	
Breaker Failure	50BF	3I>/Io>BF	RBRF	
Circuit Breaker		TCS	SCBR	For both trip
Trip Circuit				coils for each
Supervision				breaker. Alarm
Droto stivo Dolovi				Only Fail aafa
Frolective Relay				rall-sale
				internal relay
				failure or loss
				of control
				power trips the
				associated
				breaker(s)
Lookout				
LOCKOUL	86		PTRC	Breaker
LOCKOUL	86		PTRC XCBR	Breaker Reclosure

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
				associated feeder breaker
Breaker Wear Monitoring				
3. Transformer	Feeders (SEL-751	1)		
Function Description	ANSI/IEEE Function	IEC 60617 Function	IEC 61850 Function	REMARKS
Non-directional Overcurrent (Instantaneous and Time)	50/51	3 >, 3 >>, 3 >>>	PIOC PTOC	Coordinate with transformer supplier to account for magnetizing inrush current
Non-directional Earth/Ground Fault	50N/51N	I <sub>0</sub> >, I <sub>0</sub> >>, I <sub>0</sub> >>>	PIOC PTOC	
Transformer Differential with harmonic restraint	87T with 68	3dl>T with I <sub>f2</sub> > I <sub>f5</sub> >	PTDF PHAR	Implement harmonic restraint on differential protection to avoid tripping during energization
Restricted earth fault (low impedance)	87NL	dl₀Lo	PNDF	Grounded Y- windings, low- impedance type, for dry/cast-resin transformers over 1MVA and all liquid-filled transformers
Breaker Failure	50BF	3I>/lo>BF	RBRF	
Circuit Breaker Trip Circuit Supervision		TCS	SCBR	For both trip coils for each breaker. Alarm only
Protective Relay Failure				Fail-safe design that on internal relay failure or loss of control power trips the associated breaker(s)
Lockout	86		PTRC XCBR	Breaker Reclosure Lockout for the

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
				associated transformer feeder breaker
Breaker Wear Monitoring				

4. Transformer Local Protection. Coordinate with Transformer Suppliers to obtain trip signals for the following physical and backup protection functions:

Function Description	ANSI/IEEE Function	IEC 60617 Function	IEC 61850 Function	REMARKS
Non-directional Overcurrent (Instantaneous and Time)	50/51	3 >, 3 >>, 3 >>>	PIOC PTOC	Secondary winding
Non-directional Earth/Ground Fault	50N/51N	I <sub>0</sub> >, I <sub>0</sub> >>, I <sub>0</sub> >>>	PIOC PTOC	Neutral
High Voltage Winding Temperature	49W	Τ>	PTTR	No lockout, cooling circuits continue to operate
Low Voltage Winding Temperature	49W	Τ>	PTTR	No lockout, cooling circuits continue to operate
Breaker Failure	50BF	3I>/Io>BF	RBRF	
Circuit Breaker Trip Circuit Supervision		TCS	SCBR	For both trip coils for each breaker. Alarm only
Protective Relay Failure				Fail-safe design that on internal relay failure or loss of control power trips the associated breaker(s)
Lockout	86		PTRC XCBR	Breaker Reclosure Lockout
Breaker Wear Monitoring				

5. Generator Incoming Feeders (SEL-700G)

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Non-directional	50/51	3 >, 3 >>,	PIOC	Secondary
Overcurrent		3 >>>	PTOC	winding
(Instantaneous				
and Time)				
Non-directional	50N/51N	<sub>0</sub> >,   <sub>0</sub> >>,   <sub>0</sub> >>>	PIOC	Neutral
Earth/Ground			PTOC	
Fault				
Non-directional	50N/51N	<sub>0</sub> >,   <sub>0</sub> >>,   <sub>0</sub> >>>	PIOC	Ground
Earth/Ground			PTOC	
Fault				
Voltage	51V	U≯I>	PVOC	
Restrained				
Overcurrent				
Negative	46	I <sub>2</sub> >	PPBR	
sequence or				
phase-balance				
current		-		
AC directional	67G	$ I_0 \rightarrow >$	PIOC	
ground				
overcurrent	07			
Undervoltage	27	3U<	PIUV	No lockout
Overvoltage	59	30>	PIOV	No lockout
Phase-sequence	<mark>47</mark>	U <sub>2</sub> >	PPBV	No lockout
or phase-balance				
Volta par Llart	24	\//LI=>		
	24	V/HZ>	PVPH	
	250			Concreter
Chock	256		ROTIN	Syna chock
Directional	300	P( ) or P)		Motoring
	JZN	F←201-F2	FDOF	protoction
Linder frequency	8111	f<	DTUE	protection
	810	1× f>		
Eroquoney rate of	81P			
change	OIN		FFRG	
Generator	876	34120	PGDE	
Differential	0/0	50120	FGDI	
	40	Xe	PDIS	
Broaker Failure	50BE	312/102BE	RBRE	
Circuit Breaker	5001		SCBR	For both trip
			SCBIX	coils for each
Supervision				hreaker Alarm
				only
Protective Relay				Fail-safe
Failure				design that on
				internal relav
				failure or loss
				of control
Failure				design that on internal relay failure or loss of control

Function Description	ANSI/IEEE Function	IEC 60617 Function	IEC 61850 Function	REMARKS
				power trips the associated breaker(s)
Lockout	86G		PTRC XCBR	Breaker Reclosure Lockout for the associated Generator Circuit Breaker
Breaker Wear Monitoring				

6. Generator Local Protection (CAT EMCP). Coordinate with Generator Suppliers to obtain trip signals for the following physical and backup protection functions:

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
High Engine Oil	26Q	T>	PTTR	
Temperature				
High Coolant	26Q	T>	PTTR	
Temperature				
Stator Thermal	49S	T>	PTTR	
Overload				
Non-directional	50/51	3 >, 3 >>,	PIOC	
Overcurrent		3 >>>	PTOC	
(Instantaneous				
and Time)				
Negative	46	I <sub>2</sub> >	PPBR	
sequence or				
phase-balance				
current				
Undervoltage	27	3U<	PTUV	No lockout
Overvoltage	59	3U>	PTOV	No lockout
Phase-sequence	47	U <sub>2</sub> >	PPBV	
or phase-balance				
voltage				
Under frequency	81U	f<	PTUF	
Over frequency	810	f>	PTOF	
Directional	32R	P←> or -P>	PDOP	
(reverse) Power				
Reverse Reactive	32RV	Q←> or -Q>	PDQR	
Power (kVAr)				

7. Switchgear Assembly Protection

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Switchgear Bus/Busbar Differential	87B	3dl>B	PBDF	SEL 587Z: High Impedance, includes all incoming, ties and feeder

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
	07			circuits. Include clearly labeled terminal blocks for transfer/trip wiring to all upstream MV source circuit breakers
Overvoltage	Z/ 50	30<	PIUV	No lockout
Dvervollage Dbaco coguonoo	39 47	302		INU IUCKUUL
or phase-balance voltage	47	022	PPDV	
Fiber-optic based Arc Flash Detection	AF/50P			Include option on each SEL 751 relay, paired with overcurrent element to prevent false tripping on light only. Use fiber optic cable not spot sensors. Any arc flash in MV switchgear shall trip all incoming sources via output contact from 86B lockout relay.
Protective Relay Failure				Fail-safe design that on internal relay failure or loss of control power trips the associated breaker(s)
Lockout	86B		PTRC XCBR	Breaker Reclosure Lockout for all breakers in the assembly

8. Main/Incoming Breaker Failure and Transfer Trip.

a. The Supplier shall provide interfaces as required to connect the Switchgear protective relaying with the upstream breakers for the provision of a "transfer trip" or breaker failure signal.

- G. Trip Condition Annunciation
  - 1. Provide LED and appropriate text message indication on all relay front display screens as to the reason for each type of circuit breaker trip.
- H. Field Wiring Terminal Blocks
  - 1. Provide clearly labeled with English text for its function, adjacent to each terminal block point and in wiring diagrams, to denote where all field routed wiring is to be terminated.
- I. Interlocks
  - 1. Hardwired Interlocks. The following hardwired interlocks shall be incorporated as a minimum:
    - a. All closing coil signals (all close signal) shall be via the synchronizing-check protection element (25). The synchronizing-check should be able to close onto a dead bus. An alarm shall be raised if the synchronizing-check relay blocks a close signal.
    - b. The busbar ground/earth switch shall be electrically interlocked with all circuit breakers. Where applicable GOOSE interlocking may be utilized, it shall only be possible to close the busbar earth switch if all the circuit breakers are in circuit earth or open.
    - c. GOOSE interlocking shall be utilized to prevent the circuit breaker earth switch being closed into earth position, without the remote end circuit breaker being open or in circuit earth.
    - d. Where generators are used, the generator paralleling switchgear shall include the following hardwired connections and interlocks:
      - 1) Interlock to prevent two or more generators connecting onto a deadbus at the same time.
      - 2) Critical start/stop and alarm/shutdown signals from the switchgear to the engines.
      - 3) Closing and tripping signals from the engine to the switchgear.
      - 4) Provide hardwired interlocking between generator feeder breaker and associated downstream transfer switchgear generator breaker such that generator feeder breaker cannot be closed unless the downstream transfer switchgear generator breaker is open or withdrawn.
      - 5) Provide electrical interlock that prevents more than one load bank breaker located in all generator paralleling switchgears from being closed at the same time.
      - 6) Disable load bank breaker interlocks if breaker is either racked out in the test or fully disconnect positions.
  - 2. GOOSE Interlocking. IEC 61850 'GOOSE' interlocking may be provided in addition to traditional hardwired interlocks on the electrical system. GOOSE Interlocking may be used for the permissive grounding/earthing requirements.
    - a. The Goose communication shall be accomplished via Owner's Facility Network (FacNet) using IEC 62439-3 Parallel Redundancy Protocol (PRP).
    - b. As a minimum, GOOSE Interlocking shall be utilized for:

- 1) Grounding/earth switch interlocking for feeders between switchgear assemblies. It shall not be possible to close the grounding/earth switch unless the remote circuit breaker is open or grounded.
- 2) The busbar grounding/earth switch shall be electrically interlocked with all circuit breakers within a switchgear assembly. Where applicable GOOSE interlocking may be utilized for local interlocks.
- 3) 1 out of 2 interlocks for incoming feeders on load bank switchgear assembly.
- 4) 2 out of 3 interlocks on the incoming feeders of auxiliary switchgear assemblies (non-critical, non-essential supply).
- 3. Substation Transformers Interlocking. Interlocking shall be provided on the incoming/main breakers of the transformer secondary switchgear as follows:
  - a. The Main/Incoming Circuit Breaker of the transformer secondary switchgear shall not be closed unless the Transformer primary feeder circuit breaker is closed (except interlock bypass).
  - b. The Transformer primary feeder circuit breaker shall not be able to close unless the main/incoming circuit breaker of the transformer secondary switchgear is in its open status (except interlock bypass).

## 2.12 MONITORING, CONTROLS AND AUTOMATION

- A. Owner's Facility Network and Network Interfaces
  - 1. The Owner will supply an Ethernet based Facility Network (FacNet) to facilitate a network interface between the Supplier and the PDCS/EPMS/SCADA Systems. For each location the Owner will supply two redundant network switch racks. All interconnections between Owner's provided switches will be by the Owner.
  - 2. Each intelligent device provided by the Supplier shall have two independent (different MACs) RJ45 Ethernet ports for connection to the FacNet and communication to EPMS/PDCS. The Supplier shall provide Category 6a Shielded Twisted Pair (STP) copper cables to connect both ports of each device to the Owner furnished switches located in the FacNet cabinets. If switchgear assembly based local network is required and provided by the Supplier, the proposed arrangement shall be reviewed and approved by the Owner.
  - 3. The Supplier shall provide a list of devices and required ports for each switch rack to the Engineer and PDCS/EPMS/SCADA System Supplier.
  - 4. The Owner will provide a range of IP addresses. The Supplier shall liaise with the PDCS/EPMS/SCADA System Supplier to obtain and IP address and network configuration for each of the supplied devices.
  - 5. The allowed network protocols for communications to PDCS/EPMS/SCADA Systems are IEC 61850 and Modbus TCP/IP. IEC 61850 is the preferred one. IEC 62439-3 Parallel Redundancy Protocol (PRP) and Highly-available Seamless Redundancy (HSR) protocols are required, where GOOSE messaging is used.
  - 6. Supplier is responsible for ensuring all devices are setup properly and communicating reliably with the site control and monitoring system(s) (PDCS, SCADA, PLC, EPMS, ENMS, etc).
- B. Time Synchronization
  - 1. Power meters, protection relays, sequence of event recorders and other intelligent devices shall be provided with Time Synchronization. The primary type synchronization shall be via IEEE 1588 Network Timing Protocol (NTP). The

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switchgear devices shall obtain the NTP signals through the Owner's FacNet. Primary and Secondary IP addresses for the clocks shall be coordinated with the PDCS/EPMS Suppliers. The clock(s) will be provided by the EPMS Supplier.

- 2. The devices shall also be capable of accepting IRIG B time synchronization.
- C. Intelligent Device Configuration and Security
  - 1. The username and password must be changed from factory default to Owner provided credentials. The factory default password must be removed.
  - 2. If access to the device is available through a web browser on the network. It is required to use HTTPS (port 443) and disable HTTP (port 80) access.
  - 3. Configure Date and Time settings using the satellite time clock or PTP/NTP server IP address.
  - 4. Assign the device a meaningful name (do not use the factory default).
  - 5. Assign the device a meaningful location (if field is available).
  - 6. Disable Telnet access.
  - 7. Enable SSH (if available).
- D. Controls and Automation
  - 1. The electrical distribution system including the switchgear assemblies specified herein shall allow for automatic and manual control via a separate Power Distribution Control System (PDCS) as specified in section 260916 Power Distribution Control System and provided by the PDCS Supplier. Liaise with the PDCS Suppliers to coordinate the designs and provide the required equipment and interfaces. The controls portion of the system is PLC based with two redundant PLCs located in the same room as the switchgear assemblies for the specific location. The majority of the signals are dual redundant as listed in 0APPENDIX B: FIGURES, SCHEMATICS AND TABLES.
  - 2. Hardwired Interface to PDCS
    - a. Option 1. For each switchgear assembly, the critical status and control signals shall be pre-wired to a marshalling cubicle provided as part of each switchgear assembly. All auxiliary contacts and trip (open) and close coils shall be wired to terminals in the marshalling cubicle and all cables clearly labeled. All spare auxiliary contacts on protection relays, circuit breaker contacts etc. shall be wired back to the control section compartment and terminated.
    - b. Option 2. Ethernet-based Distributed I/O, free-issued by the PDCS supplier shall be used and installed in the low voltage compartments. All signals shall be wired to the I/O modules and tested at the factory.
    - c. Critical signals include breaker control and status, trips initiated by the relay for any trip functions and as agreed with the Owner.
    - d. Non-critical Status Signals. Non-critical status signals such as heater monitoring, etc. can be connected locally to the Protective Relay, Power Quality Meter or Power Meter for the cubicle in lieu of hardwiring them to the marshaling cubicle. Connection of signals shall be coordinated with the PDCS/EPMS/SCADA System Suppliers.
  - 3. For Power Systems with generators, liaise with the MV Diesel-Engine-Driven Generator Sets and PDCS Suppliers to coordinate the designs and provide the required equipment and interfaces. All generator control interfaces shall be hard wired control signals. As a minimum provide the following hardwired interface to the Diesel-Engine-Driven Generator sets for each Generator Circuit Breaker section:
    - a. To generator

- 1) Breaker Open Status
- 2) Breaker Closed Status
- b. From generator
  - 1) Trip command
- E. Power Quality and Power Metering
  - 1. Multi-function power quality meters and power meters shall be provided and located as specified here in and/or shown on the Drawings. As a minimum the following meters shall be provided
    - a. IncomingGenerator & Normal power Main feeders on TS switchgear and on the total generator bus output point in the GS switchgear: Power Quality Meter with waveform capture Schneider Electric PowerLogic PM8240 series or approved equal.
    - b. Feeder Breakers: Power Meter PowerLogic PM5240 series or approved equal, NTP support is preferred. Using Feeder Protection Relays for metering is also acceptable.
  - 2. PDCS/EPMS/SCADA System interface shall be via the FacNet as specified herein.
  - 3. Required Input/Output modules shall be provided for connection of non-critical status signals.
  - 4. Provide with the following features:
    - a. Comply with IEEE 1159 and IEC EN50160 Standards
    - b. Inputs from sensors or current-transformer secondaries, and potential terminals rated to 600 V.
    - c. Detect and record transients by sampling the waveform every 200 ns for all seven categories of electromagnetic disturbance as defined by IEEE. Disturbance categories are:
      - 1) Impulse: High, medium, low and oscillatory
      - 2) Short Duration: Sags, swells and interruptions
      - 3) Long Duration: Undervoltages, overvoltages and interruptions.
      - 4) Voltage: Steady state unbalanced loads
      - 5) Harmonic Distortion
      - 6) Intermittent Voltage
      - 7) Frequency Deviation
      - 8) Accumulated energy, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
    - d. Ethernet communications module for remote monitoring of meter quantities and functions using IEC61850. Coordinate with the EPMS supplier
    - e. Time clock synchronization.
    - f. Event recording with 128 MB memory.
    - g. ITIC envelope monitoring.
    - h. Mounting: Display and control unit that is flush or semi-flush mounted in instrument compartment door.
- F. Sequence of Event Recording (SER)

- 1. The protective relays and power meters specified herein for each switchgear section shall be fitted with 1ms rated Input/Output modules and perform the SER function. The data shall be communicated to the PDCS/EPMS/SCADA System.
- 2. Where critical signals are wired directly to PLCs, I/Os, PDCS, the Supplier shall liaise with the PDCS supplier to select SER capable input cards with 1ms resolution as a minimum and time stamping at the card.
- 3. Where PM8000 series meters are present all circuit breaker's SER open/close, bell alarm and withdrawn status events shall be routed to the SER digital inputs on that device. Include SER expansion cards as required.
- G. Local Breaker Control and Indication
  - 1. Hardwired local control switches and indicators are not required
  - 2. Protective relays shall be used for local/remote switching, breaker operation and indication. Breaker operation shall be double action, to avoid mis-operation. Lockout functionality should be performed by the protective relay.
  - 3. Interface to remote wired operation shall be provided for use with Remote Control Device as specified in the Accessories paragraph herein.

## 2.13 LOW VOLTAGE WIRE AND TERMINATIONS

- A. Heavy-duty (Utility) Terminal Blocks:
  - 1. General:
    - a. Ratings: 600 V, 30 amps.
    - b. Molded one-piece thermoplastic body.
    - c. Washer head terminal screws to accommodate up to a #10 AWG wire.
  - 2. Current transformer shorting terminal blocks:
    - a. Short circuiting strip for shorting screws and screw "parking stations."
  - 3. Non-shorting terminal blocks
- B. Control Wire:
  - 1. Conductor shall be stranded copper with 600 V rated insulation.
  - 2. Surface mark with manufacturers name or trademark, conductor size, insulation type and UL label.
  - 3. Conform to UL 44 for type SIS or MTW insulation.
- C. Terminators:
  - 1. Ratings: 600 V.
  - 2. Tin plated high strength copper alloy.
  - 3. Solderless, non-insulated, ring type.
- 2.14 LABELING
  - A. Warning signs and labels inside and outside unit shall be provided as may be appropriate for the switchgear. In addition to Arc flash warning labels, each panel covering a section of the switchgear, which provides access to medium voltage parts shall be provided with a suitable danger of death warning label to ISO 7010 standard to prohibit removal while Switchgear is energized.
  - B. A nameplate shall be visible with the Switchgear's ratings, manufacture's name, catalog number, date of manufacture and serial number.
  - C. Externally visible, permanent nameplates shall be provided to identify each Switchgear assembly, bus, meter, protective relay, test switch, circuit breaker compartment, etc. Relays shall be designated as to use. Equipment and terminal blocks within the compartments shall also be suitably identified. Nameplates shall be supplied with

inscriptions as per Drawings and approved by the Owner. Outgoing transformer feeder sections shall also be labelled with the name of the transformer which it is feeding. A separate label with characters of at least 100mm high shall be fixed to the center of the switchgear assembly by its equipment reference compliant with the Owner's naming convention.

- D. Nameplates shall be laminated plastic, 2.38 mm (3/32-inch) thick, attached with non-ferrous screws. Characters shall be black engraved on a white background. Master nameplates are to be 100mm (4-inches) high by 300mm (12-inches) long with black engraved lettering on a white plate background. Function nameplates shall be 50mm (2-inches) high by 150mm (6-inches) long with black engraved lettering on a white plate background. (Other specification sections may supersede the requirements of this paragraph. Refer to the Owner at time of bid for alternate or additional identification requirements.)
- E. Mimic bus shall be displayed on each Switchboard section. Each device in the mimic bus graphic shall be clearly labeled. Location of CTs, PTs, relays and metering shall be shown. Mimic shall be painted on or made of permanent adhesive tape made specifically for the application. Lines shall be 1/2 inch wide for bus graphic, 3/8 inch wide for device graphic and 1/2 inch wide for auxiliary lines (CT's, PT's, etc.). Main Bus graphic shall be black and device graphic shall be blue. Submit layout for review.

### 2.15 ACCESSORIES

- A. The Supplier shall furnish all accessories required for testing, inspection, maintenance and operation of the switchgear, for each room housing MV switchgear, including, but not limited to:
  - 1. Trolleys for breaker handling and racking.
    - a. The Supplier shall provide one trolley/maintenance cart, suitable for removing all withdrawable circuit breakers associated with the switchgear. The trolley shall be sized for the load and have a minimum safe working load of at least 450 kg or higher.
    - b. The trolley shall include the facility of remote racking of the circuit breaker. The remote racking facility shall be suitable for both racking a circuit breaker into and out of each position including Connected/Racked-In; Test (when separate test position provided); and Disconnected/Racked-Out positions.
  - 2. Breaker racking handle.
  - 3. Ramps for instrument transformers.
  - 4. Remote Control Device. Provide one remote control device ("umbilical cord") for each switchgear room with 25 feet /7.5m cord that allows in room corded remote operation for each circuit breaker.
  - 5. Maintenance tool for manually charging the breaker closing spring and manually opening the shutters.

#### 2.16 OUTDOOR ENCLOSURE

- A. If an Outdoor Enclosure/eHouse required, it shall be in accordance with Specification 261326 Outdoor Switchgear Enclosure.
- 2.17 SOURCE QUALITY CONTROL
  - A. The Owner, and its representatives shall have the right to inspect all equipment covered by this Specification at any time and to witness any tests made on the equipment. The

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Manufacturer shall notify the Owner in writing at least 10 working days prior to shipment to permit the Owner the option of inspecting the equipment at the factory.

- B. Level 1 Commissioning, Fabrication Phase.
  - 1. Test procedures shall be submitted to the Owner/EOR for review and approval.
  - 2. Additional Level 1 tests shall be as follows:
    - a. Dielectric Test: Each Switchgear lineup shall be subjected to a dielectricstrength test in accordance with the referenced standards.
    - b. Meter Accuracy Check: Meters shall be checked for accuracy and adjusted.
    - c. Functional Checks: All components, including breaker controls, racking mechanisms, interlocks and lockout devices, shall be tested to determine proper operation. All control functions, key interlocks and indicators shall be verified.
    - d. Protective Relay Tests: Perform secondary injection testing of each relay via the relay CT shorting/test blocks. Simulate PT voltages as required. Simulate functions over GOOSE.
    - e. Communication Tests: Internal and inter assembly communication shall be tested and verified
    - f. Interface to PDCS/EPMS Tests: The Vendor shall liaise with the SCADA/ENMS vendor to
  - 3. Level 1x Factory Prototype Test. The first switchgear assembly and eHouse shall be used as a prototype and tested to validate the design prior to commencing final auxiliary equipment placement and wiring for the subsequent assemblies. The test will be witnessed by the Owner and/or Owner's representatives. Any modifications resulting from the testing shall be implemented prior to subsequent testing. This test may include portions or all of integrated test 1b.
  - 4. Level 1a FAT/FWT Switchgear Assemblies. Perform as required.
  - 5. Level 1b FAT/FWT for Integration. The Manufacturer shall liaise with the EPMS/ENMS and PDCS vendors to set up and perform an integrated test in the Manufacturer's facility with FacNet for the scope functional. Integration and operation of the two systems as a whole shall be demonstrated, including, but not limited to: metering integration; protection system operation and integration; breaker and controls integration and operation; sequence of operation testing; maintenance isolation and operation, and others.
- C. The Owner reserves the right to omit some or all of the FWTs.
- D. Factory test results shall be submitted for review and approval.
- E. The equipment shall not leave the factory until the factory tests are satisfactorily demonstrated and the system accepted.

### PART 3 - EXECUTION

#### 3.1 INSTALLERS

A. Where the equipment is installed off-site in an enclosure or eHouse and then delivered to the site, the entity placing the equipment in the enclosure/eHouse shall assume the Contractor's installation responsibility for the off-site work.

### 3.2 EXAMINATION AND PREPARATION

A. The Contractor shall verify dimensions, tolerances and method of attachment with other work.

- B. The Contractor shall verify that openings, conduit stub-ups and overhead works align with the equipment to be installed in place.
- C. The Contractor shall verify that anchoring devices have been properly installed and located.
- D. Installation work can only proceed if the installation location is examined and prepared to receive the equipment. Notify Owner and its representatives, if area preparation does not conform to the installation requirements and tolerances.

### 3.3 CLEANING AND PROTECTION

- A. After receipt of equipment and prior to acceptance, the Contractor shall keep the installed products clean and shall provide adequate equipment protection throughout the project.
- B. At no time shall personnel be allowed to sit or stand on equipment enclosures or use them as support for working above. Internal components, electronics, coils and windings, shall be kept clear of dust, filings and other construction debris.
- C. Temporary Heating: Apply temporary heat to the equipment, according to manufacturer's written recommendations, throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.
- D. Cleaning: Inspect interior and exterior of installed equipment. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish. Periodic cleaning shall be performed where required. The equipment shall be given a thorough cleaning prior energization and prior to turn-over.
- E. Any damage to the equipment prior to turn-over shall be corrected to original condition and to the Owner's satisfaction at the Contractor's cost.

#### 3.4 INSTALLATION

- A. The Supplier shall provide installation instructions and assist the field personnel with the interpretation of the instructions and provide installation clarifications as required.
- B. The Contractor shall perform all the work necessary for a functionally complete installation, including openings in structures, holes, penetrations, bases, equipment pads, support steelwork, containments, etc. The Contractor shall provide all associated external materials for power connections, extension of control power circuits, and monitoring. All rigging required for unloading and installation shall be the responsibility of the Contractor.
- C. In addition to the Manufacturer's instructions, the Contractor shall comply with the following:
  - 1. Equipment Mounting:
    - a. The equipment shall be installed following the procedures set forth by the Supplier. The Supplier shall assist the Contractor as required in interpreting the installation instructions. The Contractor shall certify to the Supplier and the Engineer that the installation has been performed per the Supplier's latest documents and instructions.
    - b. Concrete equipment pads shall be provided where shown on the Drawings. The pads shall extend between not less than 1.5 inches beyond the dimensions of the equipment base structure, with additional extension where auxiliary transformers are located. Pad height shall be coordinated with the

breaker removal requirements (e.g. breaker extraction trolley) and the surrounding grade. If equipment is mounted in an outdoor enclosure/eHouse, pads are not required.

- c. The Contractor shall solidly anchor all equipment to the equipment pads. Embedded anchor bolts shall be provided by the Contractor and approved by the Manufacturer. No anchoring devices shall be installed outside the overall dimensions of the equipment.
- d. All penetration through walls, partition etc., shall be fully sealed without compromising the air integrity of the spaces. In addition, all fixtures and electrical accessories, electrical devices, and detectors shall not compromise the air integrity of the spaces.
- 2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and applicable codes and standards.
- 3. Connections:
  - a. Interconnect system components. Make connections to supply and load circuits according to wiring diagrams unless otherwise indicated. The cabling installation shall be carried out compliant with code requirements as well as project specifications including "26 05 00 Common Work Results for Electrical" and other relevant sections.
  - b. The Contractor shall provide all termination lugs and cable termination kits required to make up cable terminations. Power wiring lugs shall be 2-hole standard pattern drilled long barrel double compression type matching the terminal bus configuration, landed with conical washers and hardware with per Manufacturer's specification, SAE grade 5 (Class 8.8) as a minimum, and torqued per the Manufacturer's specifications or, if Manufacturer's specifications are not available, per drawing details. The Contractor shall verify the cable size and quantity with the Engineer prior shipment.
  - c. Both ends of the cable sheath/jacket shall be bonded to the earth bar of the switchgear.
- 4. Grounding
  - a. Separately Derived Systems: If not part of a listed power supply for a dataprocessing room, comply with code requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.
- 5. Identification
  - a. Identify components and wiring according to the project specific Identification for Electrical Systems requirements.
- 6. The Contractor shall refer to the appropriate construction specifications and drawings for the installation requirements for conduits, wire, terminations, boxes and testing. Connect equipment ground buses to common building ground system. Tighten bus joint, connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in codes and standards (USA: UL 486A and UL 486B).
- D. Safety Requirements.
  - 1. The Contractor shall carry out the necessary risk assessment relating to working with electrical equipment. In addition to the standard PPE required (protective helmets, eye protection, respiratory protection, gloves, protective shoes, high visibility vest, etc.), as a minimum arch flash protection, insulating rubber gloves, leather protective gloves shall be used for the application.

2. Arc-flash labels shall be applied prior to energization of equipment.

## 3.5 FIELD QUALITY CONTROL

- A. The Contractor shall execute quality control and testing activities related to the equipment specified herein in accordance with specifications "01 45 16.13 Contractor Quality Control", "01 45 29 Testing Agency Services" and "26 05 93 Electrical Equipment Testing Requirements. Additional testing and commissioning requirements are described under paragraph 3.6.
- B. Manufacturer's field service
  - 1. The Manufacturer shall attend a schedule coordination meeting at the site prior to start of construction for the purpose of integrating installation schedule of other Suppliers and the Contractor.
  - 2. Qualified manufacturer's field representatives shall be on-site at the start of construction to observe installation of switchgear assemblies, inspect, test, adjust components and assemblies and facilitate on-site support from installation through various levels of Commissioning activities. Site testing may require weekend or overtime work. Based on qualifications and performance, the Owner or the Owner's representatives, may direct the Supplier to replace the field representatives.
  - 3. Field testing and commissioning requirements are described under paragraph 3.6.
  - 4. During switchgear startup and if repair required, field service must be unlimited and must continue until satisfactory system operation and Engineer's approval has been achieved.
  - 5. The time for on-site support through construction and commissioning period shall be indicated in the scope of work and base bid price.
- C. Non-conformance
  - 1. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner.
  - 2. The Owner and its Representatives reserve the right of rejection at the job site if the above conditions are discovered even after acceptance at the factory.

### 3.6 SITE ACCEPTANCE TESTING, STARTUP & COMMISSIONING

- A. General Requirements
  - 1. Functional description of the required testing is provided in paragraph 1.12.
  - 2. The Supplier shall provide installation and startup checklists to the Owner and General Contractor for their review and acceptance, prior to commencing Level 2 Commissioning.
  - 3. The Supplier shall review and comment on Level 4 testing scripts provided by the Commissioning Agent.
  - 4. The Supplier shall provide the necessary equipment, consumables (including air filters), labor, accessories, test instruments, meters, freight and shipping costs, transportation and subsistence costs necessary to accomplish the Level 3 startup as it relates to the switchgear assemblies specified herein. All test equipment shall be laboratory calibrated and certified.
  - 5. The switchgear Supplier shall provide the services of an adequate number of personnel including manufacturer's factory- trained representatives to start up and commission the switchgear assemblies, then to operate the systems during the

site acceptance tests and to check all details of the installation. Include, at no additional cost to the Owner, the services of these personnel and representatives for the duration of the testing. Include all overtime, off-hour, weekend, or holiday work necessary for the site acceptance testing at no additional cost to the owner.

- 6. The Contractor shall provide electrical trade labor for site tests.
- 7. The CxA shall submit test procedures for commissioning. Test procedure shall be reviewed by the Engineer and Manufacturer.
- 8. The Supplier shall coordinate with the Engineer and Owner all testing times and dates. Notify the Engineer, and Owner's Representative a minimum of 14 days before the start of site acceptance testing.
- 9. Perform all tests without making adjustments to the system during the test. Failure of any component or system will require the components to be replaced or repaired and all tests repeated.
- 10. The site acceptance tests must be conducted in the presence of the Electrical Contractor and the General Contractor. The Owner, the Architect/Engineer and the CxA may also request to be present.
- B. Level 2 Commissioning Equipment Installation (Level 2 Commissioning)
  - 1. Upon delivery, inspect equipment for:
    - a. Equipment shipped matches the equipment tested during Level 1 FAT
    - b. There are no alterations to the equipment after Level 1 FAT
    - c. There is no damage to the equipment from transportation
    - d. Equipment that was tested in the factory as a group shall be installed as a group.
    - e. Confirm the tilt, shock and vibration devices show no abnormal shocks or tilts during transit.
  - 2. After installation, check and verify:
    - a. Equipment installed in accordance with the Manufacturer's requirements Complete installation and startup checks according to manufacturer's written instructions.
    - b. Equipment installed in accordance with drawings, plans and specifications
    - c. Installation is compliant with local codes and standards and health and safety requirements.
    - d. Equipment is accessible for operation and maintenance
    - e. Perform visual and mechanical inspections on the complete switchgear installation including individual cubicles, input and output connections, and all other associated equipment and components.
    - f. Verify that electrical wiring installation complies with manufacturer's submittal and with written installation requirements in other electrical Sections.
- C. Supplier Startup (Level 3 Commissioning)
  - 1. Develop and update check lists and scripts for Level 3 Testing
  - 2. Verify incomer and feeder power connections.
  - 3. Set field-adjustable settings in accordance with Engineer approved parameters and applicable circuit-breaker trip ranges as indicated.
  - 4. Power up and verify operation of each component.
  - 5. Verify that all switches, status lights, alarm lights, audible alarms, meters, and other operational devices are functioning properly.
  - 6. Functional check of all power train components, under load and for all modes of operation, to determine proper operation.

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- 7. Simulate malfunctions and failures to verify the proper operation of protective devices. Indicate on test form which protective devices were tested, how they were simulated, and the resulting operation of the system. Record all trip points.
- 8. Verify all inhibit functions and indicators.
- 9. Verify operation of hardwired and Ethernet interfaces. Confirm proper communication and readings at PDCS/SCADA/EPMS. Provide alarm logs confirming trip points tested.
- 10. Steady State Tests. For each assembly and cubicle, the voltage, input, current, power factor, kW, kVA shall be measured and recorded. These measurements shall be compared with the corresponding meter displays to verify that the switchgear meters are in calibration. Loads shall be coordinated with the CxA.
- D. Functional System Testing (Level 4 Commissioning)
  - 1. Switchgear Supplier shall provide support to CxA for Level 4 commissioning.
  - 2. CxA to provide list of indications, parameter values, and system responses considered satisfactory for each test action. Included will be tabulation of actual observations during test
- E. Level 5 Integrated System Testing (IST)
  - 1. Following the completion of all system and component testing and before applying critical load to the system an overall Integrated System Test (IST) will be conducted on the complete critical electrical distribution system.
  - 2. Upon completion of the Level 4 switchgear acceptance tests, the Manufacturer shall be available to support an Integrated Systems Test (IST) in which the switchgear will be tested as an integral part of the overall facility, to verify compatibility with the other mechanical and electrical systems. The participation shall include:
    - a. Review and approval of integration test procedures produced by the Engineer or Commissioning Agent, and assurance to the Owner that such tests will not be destructive or void warranties.
    - b. Attendance at test scheduling meetings, or provision of information as required by the Contractor to properly schedule the Vendor's activities through the testing period.

# 3.7 ELECTRICAL FIELD TEST REPORTS

- A. The Manufacturer, Supplier and independent testing agencies shall supply their certified test reports and data for each of the factory and site tests conducted by them as specified herein.
  - 1. Test Reports
    - a. All test data shall be recorded and certified by the Manufacturer or testing agency conducting the aforementioned tests. Any defects noted during the tests performed shall be brought to the attention of the Engineer for corrective action. Submit electronic and three (3) hard copies and soft copies (.pdf format) of all test reports for approval and/or corrective actions.
    - b. Each test report set submitted shall be clearly identified by the Purchaser's name, the project name, the purchase order numbers, the equipment description and specific identification, and the manufacturer's name and address. Each individual document shall be legible and shall have reproducible capability.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the switchgear and associated equipment.
- B. For the initial installation of a new Manufacturer, provide an Add price for Training in the Bid.
  - 1. Engage a qualified trade or manufacturer's representative to provide the instructions on each major piece of equipment. This trainer may be the start-up technician for the piece of equipment, the installing contractor, or a manufacturer's representative. Trainers shall be factory-trained and authorized. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. Specifically, the trainer must have site specific knowledge as well as general knowledge of the system. More than one party may be required to execute the training.
  - 2. Start training with classroom sessions followed by hands-on training on each piece of equipment.
  - 3. Classroom training shall use slides, drawings, and O&M manuals to cover as a minimum:
    - a. Purpose and function of the equipment
    - b. A brief working knowledge of the operating theory of the equipment
    - c. Submittal drawings, catalog data, and O&M manual content and organization
    - d. Available parts lists, including recommendations regarding parts that should be readily available and stored on site
    - e. Local representatives for service, parts, and repair, including contact information
    - f. Startup, shutdown, normal operation, and emergency operating procedures
    - g. Safety and emergency procedures including proper precautions when around equipment
    - h. Daily, weekly, monthly, quarterly, semiannual and annual routine preventative maintenance requirements and procedures
    - i. Required equipment exercise procedures and intervals
    - j. Normal and major repair procedures
    - k. Equipment inspection and troubleshooting procedures including the use of applicable test instruments
    - I. Routine and long-term calibration procedures
    - m. Identify location of all related equipment power disconnect switches, fuses and circuit breakers
  - 4. Site Demonstrate is required for the following:
    - a. Equipment exercise procedures
    - b. Demonstrate and perform standard operating procedures and checks
    - c. Demonstrate routine preventative maintenance activities including mechanical and electrical adjustments and calibration
    - d. Demonstrate routine disassembly and assembly of equipment if applicable
    - e. Identify and review safety items and perform safety procedures
    - f. Hands-on training shall be on-site and use O&M manuals as a guide to cover as a minimum:
    - g. Equipment section functions
    - h. Site and equipment specific interlocks and control functions
    - i. Instrumentation and controls, and interpretation of displayed information
    - j. Demonstrate startup and shutdown procedures
- 5. Identify location of all related equipment power disconnect switches, fuses and circuit breakers
  - a. Demonstrate required equipment exercise procedures
  - b. Demonstrate and perform standard operating procedures and checks
  - c. Demonstrate routine preventative maintenance activities that are part of the DCOPs maintenance scope.
  - d. Demonstrate routine disassembly and assembly of equipment if applicable
  - e. Identify and review safety items and perform safety procedures
- C. Training Duration and Schedule
  - 1. Minimum for initial training shall be 40 hours, but the period shall be longer if required to complete the training tasks described herein.
  - 2. Training sessions shall be scheduled with classroom sessions interspersed with hands-on field instruction in logical sequence.
- D. Training Plan Submittals & Timing
  - 1. Develop a preliminary training plan outline and schedule of training dates and submit to the Owner's Representative for review and approval a minimum of 60 days before the planned training sessions.
  - 2. Once the training plan outline is approved, submit one complete set of lesson plans, training manuals, handouts, visual aids and reference material organized in tabbed binder(s) to the Owner's Representative for review and approval a minimum of 30 days before the planned training sessions.
  - 3. Provide training materials to Owner's Representative 7 days before the planned training sessions. Provide one set of materials for each trainee as directed by Owner, up to a maximum of 10 copies. Additional copies shall be provided at the cost of reproduction without mark-up if requested by Owner's Representative.
  - 4. Provide an Attendance Sign-in sheet as part of the training submittal package.
  - 5. Provide final training materials in electronic format capable of being stored on a servers without loss of fidelity or organization. All documents shall be bookmarked for the sections as indicated above.
- E. Training Video
  - 1. Owner shall be authorized to record all demonstration and training sessions at Owner's option and expense.
  - 2. Video materials shall be provided in a format that allows for transfer to network storage and seamless access from internal cloud sites.

END OF SECTION

APPENDICES FOLLOW BELOW

#### APPENDIX A: MV SWITCHGEAR RATINGS

Description	Unit	Ratings	Remarks
I. Service Conditions			
Location, altitude, wind speed, seismic, air pollution and other location specific requirements.	-	See Specification 01 81 16 Facility Environmental Data	<1,000 m elevation
Installation Location/Service	-	In Indoor Electrical rooms	
Maximum/Average/Minimum Ambient Temperature	°C	40/30/-30	
Governing Standards		USA, ANSI/IEEE	
II. Main Data			
Switchgear Type		Metal-clad, freestanding, alternating current, modular and extendable	
Insulation		Vacuum-insulated	
Partition Class		PM	
Ingress Protection		IP44/NEMA3 for enclosure IP2x between compartments	
Compartment Access		Busbar Compartment: Tool based access Switching Device Compartment: Interlock based access Cable & CTs Compartment: Interlock based access Low Voltage Compartment: Non- restricted access All other Compartments: Tool based access	
Loss of Service Continuity Category		LSC 2B	IEC 62271-200
Circuit Breaker Mounting		Withdrawable	
Enclosure Color		RAL 7035 Light Grey	
Conformity & Compliance		Follow location requirements as stated in Specification 01 81 16 Facility Environmental Requirements	
Framework Steel Minimum Thickness		2.78 mm / 12-gauge (US Code Title 15 §206)	
Bottom Plate Steel Minimum Thickness		4.76 mm / 7-gauge (US Code Title 15 §206)	
Bottom Rail Minimum Height		100 mm (4")	
Phases		3	
Frequency	Hz	60	
Voltage Class	kV	15	
Nominal Voltage	kV	Garin: 13.8 Tilden: 12.47	
Rated Power Frequency Withstand Voltage	kV rms	36	

Description	Unit	Ratings	Remarks
Rated Lightning Impulse	kV	95	
Withstand Voltage (BIL)	peak		
Rated Short Circuit	kA	40, 3 s	
Interrupting Current	rms		
Peak Withstand Current	kA	104	
	peak		
Internal Arc Classification		ANSI/IEEE C37.20.7: Type 2B	With LV/control
		IEC 62271-200: IAC A FLR	compartment
			open
Internal Arc Withstand	kA	40, 0.5 s, or as shown on drawings,	With LV/control
Current		whichever is higher.	compartment
			open
Busbar All Sections -	А	As shown on single line diagrams	
Minimum Rating			
Busbar Arrangement		Single	
Busbar Material All Sections		Copper	
Busbar insulation		Yes	
Power terminations		Two-hole, long barrel, double crimp	
		compression type lug terminations	
Cable Termination Space		Suitable to accommodate the	
Allowance		number of cables per design,	
		minimum 750 millimeters (29	
		inches) long	
Anticondensation Heaters		Where required	
Power Supply: Control,	V DC	125	two independent
Protection, Indication,			redundant
Breaker Charging and Truck			sources
Motors			
Tripping Mechanism	V DC	70-140	
Operating Range		-	
Number of Trip Coils		2	All breakers
Closing Mechanism	V DC	90-140	
Operating Range			
Breaker Average Rated	ms	≤50	
Interrupting Time			
Power Supply: Internal		Single-phase 115VAC, 60Hz	
Lighting			
IVIINIMUM VVIre Size			
Instrument Transformers		Europe/China: 4 mm <sup>2</sup>	
(CI, PI/VI) CIrcuits			
		USA: AVVG 14	
Time Champing for Circult			
I me Stamping for Signals		IEEE 1588 Precision Time Protocol	1 millisecond or better
Voltage/Potential			
Transformers			
Standard		IEEE C57.13	
MEDIUM		E CIRCUIT BREAKER SWITCHGEAR	2

Description	Unit	Ratings	Remarks
Secondary Voltage	V	ANSI: 120/69.3	For rated primary
		IEC: 100/57.7	voltage
Accuracy	%	0.5%	
Current Transformers			
Standard		IEEE C57.13	
Secondary Current	А	5	For rated primary
			current
Accuracy Protection		ANSI/IEEE C57.13: C400	
		IEC60044-1: 30VA 5P20	
Accuracy Metering		ANSI/IEEE C57.13: 0.3 B0.5	
		IEC60044-1: 0.5%	
Surge Arresters			
Standard		IEEE 62.11	
Rating	kV	18	Phase to Phase
			(resistance
			grounded system)

# APPENDIX B: FIGURES, SCHEMATICS AND TABLES



Figure 1 – Typical Network Diagram

Table 1: Switchgear Signals		
Description	Unit/Type	Remarks
Control Signals to each Breaker		
Close Breaker	COMMAND	PLC "A"
Close Breaker	COMMAND	PLC "B"
Open/Trip Breaker Coil 1	COMMAND	PLC "A"
Open/Trip Breaker Coil 2	COMMAND	PLC "B"
Status Signals from each Breaker		
Breaker Status Closed 52a	STATUS	PLC "A"
Breaker Status Closed 52a	STATUS	PLC "B"
Breaker Status Opened 52b	STATUS	PLC "A"
Breaker Status Opened 52b	STATUS	PLC "B"
Breaker Tripped	ALARM	PLC "A"
Breaker Tripped	ALARM	PLC "B"
Breaker Racked In	STATUS	PLC "A"
Breaker Racked In	STATUS	PLC "B"
Grounding Switch Engaged		PLC "A"
Grounding Switch Engaged		PLC "B"
Automatic Mode Selected		PLC "A"
Automatic Mode Selected		PLC "B"
Phase failure		
Signals for each Switchgear Assembly		
Bus Phase Failure		
Heater Failure		For each heater installed.
COMMUNICATION (NETWORK)		
Protective Relay Signals (Network)	Multiple signals selected by the Owner based on Relay Type	Dual Ethernet (copper) connection utilizing protocol IEC 61850 or Modbus TCP/IP
Power Quality Meters (Network)	Multiple signals selected by the Owner based on Meter Type	Dual Ethernet (copper) connection utilizing protocol IEC 61850 or Modbus TCP/IP

# **Power Quality Meter**

				Point	Alarm		Trend
Device	Item	Measurement	Unit	Туре	Priority	Graphics	Database
(0)	1	Active Energy	kWH del-rec	ANALOG			Х
n n	2	Active Power	kW total	ANALOG		х	х
qr	3	Apparent Energy	kVAh del-rec	ANALOG			х
Ö	4	Apparent Power	kVA total	ANALOG		х	х
Š	5	Current A	amps	ANALOG		х	х
	6	Current Avg	amps	ANALOG		х	х

# **Power Quality Meter**

Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database
201100	7	Current B	amps	ANALOG	,	X	X
	8	Current C	amps	ANALOG		Х	Х
	9	Current G	amps	ANALOG		х	х
	10	Demand Active Power	kW sd del-rec	ANALOG			х
	11	Demand Apparent Power	kVA sd del-rec	ANALOG			х
	12	Demand Reactive Power	kVAR sd del-rec	ANALOG			х
	13	Frequency	Hz	ANALOG		Х	
	14	Power Factor		ANALOG		х	
	15	Reactive Energy	kVARh	ANALOG			х
	16	Reactive Power	kVAR total	ANALOG		Х	х
	17	THD Voltage A-B	THD	ANALOG			
	18	THD Voltage A-N	THD	ANALOG			
	19	THD Voltage B-C	THD	ANALOG			
	20	THD Voltage B-N	THD	ANALOG			
	21	THD Voltage C-A	THD	ANALOG			
	22	THD Voltage C-N	THD	ANALOG			
	23	Voltage A-B	volts	ANALOG		х	
	24	Voltage A-N	volts	ANALOG		х	
	25	Voltage B-C	volts	ANALOG		Х	
	26	Voltage B-N	volts	ANALOG		Х	
	27	Voltage C-A	volts	ANALOG		Х	
	28	Voltage C-N	volts	ANALOG		Х	
	29	Voltage L-L Avg	volts	ANALOG		Х	
	30	Voltage L-N Avg	volts	ANALOG		Х	
	31	Over THD Voltage A-N	THD	ANALOG	3		
	32	Over THD Voltage B-N	THD	ANALOG	3		
	33	Over THD Voltage C-N	THD	ANALOG	3		
	34	Over Voltage A-N	THD	ANALOG	3		
	35	Over Voltage B-N	THD	ANALOG	3		
	36	Over Voltage C-N	THD	ANALOG	3		
	37	Over Voltage Unbalance L-L Worst	Over V unbl	ANALOG	3		
	38	Over Voltage Unbalance L-N Worst	Over V unbl	ANALOG	3		
	39	Sag Van	DAN2 limit exeeded	ANALOG	2		

# **Power Quality Meter**

Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database
	40	Sag Vbn	DAN2 limit exeeded	ANALOG	2		
	41	Sag Vcn	DAN2 limit exeeded	ANALOG	2		
	42	Swell Van	DAN4 limit exceeded	ANALOG	3		
	43	Swell Vbn	DAN4 limit exceeded	ANALOG	3		
	44	Swell Vcn	DAN4 limit exceeded	ANALOG	3		
	45	Under Voltage A-N	V1 Under E	ANALOG	2		
	46	Under Voltage B-N	V2 Under E	ANALOG	2		
	47	Under Voltage C-N	V3 Under E	ANALOG	2		

# Medium Voltage Protective Relay

Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database
	1	27P Undervolt Trip		DIGITAL	1		
	2	27P2 Under Voltage Warning		DIGITAL	2		
	3	50 Phase A Trip		DIGITAL	1		
	4	50 Phase B Trip		DIGITAL	1		
	5	50 Phase C Trip		DIGITAL	1		
	6	50G1 Ground Trip		DIGITAL	1		
	7	50G2 Ground Warning		DIGITAL	2		
col	8	50G3 Ground Warning		DIGITAL	2		
roto	9	50G4 Ground Warning		DIGITAL	1		
50 p	10	50N1 Neutral Trip		DIGITAL	2		
618	11	50N2 Neutral Warning		DIGITAL	2		
IEC	12	50N3 Neutral Warning		DIGITAL	2		
	13	50N4 Neutral Warning		DIGITAL	2		
	14	50P1 Phase Trip		DIGITAL	1		
	15	50P2 Phase Warning		DIGITAL	2		
	16	50P3 Phase Warning		DIGITAL	2		
	17	50P4 Phase Warning		DIGITAL	2		
	18	50Q1 Negative Sequence Trip		DIGITAL	1		
	19	50Q2 Negative Sequence Warning		DIGITAL	2		

Me	Medium Voltage Protective Relay							
Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database	
	20	50Q3 Negative Sequence Warning		DIGITAL	2			
	21	50Q4 Negative Sequence Warning		DIGITAL	2			
	22	51 Negative Sequence Trip		DIGITAL	1			
	23	51 Phase A Trip		DIGITAL	1			
	24	51 Phase B Trip		DIGITAL	1			
	25	51 Phase C Trip		DIGITAL	1			
	26	51G1 Ground Trip		DIGITAL	1			
	27	51G2 Ground Warning		DIGITAL	2			
	28	51N1 Neutral Trip		DIGITAL	1			
	29	51N2 Neutral Warning		DIGITAL	2			
	30	51P1 Phase Trip		DIGITAL	1			
	31	51P2 Phase Warning		DIGITAL	2			
	32	55 Power Factor Trip		DIGITAL	1			
	33	59P Overvolt Trip		DIGITAL	1			
	34	59P2 Over Voltage Warning		DIGITAL	2			
	35	81D1 Frequency Trip		DIGITAL	1			
	36	81D2 Frequency Trip		DIGITAL	1			
	37	81D3 Frequency Warning		DIGITAL	2			
	38	81D4 Frequency Warning		DIGITAL	2			
	39	Active Energy Into the Load	kWH	REAL			Х	
	40	Active Energy Out of the Load	kWH	REAL			Х	
	41	Active Power	kW	REAL			Х	
	42	Active Power A	kW	REAL			Х	
	43	Active Power B	kW	REAL			Х	
	44	Active Power C	kW	REAL			Х	
	45	Apparent Energy	kVAH	REAL			Х	
	46	Apparent Power	kVA	REAL			Х	
	47	Apparent Power A	kVA	REAL			Х	
	48	Apparent Power B	kVA	REAL			Х	
	49	Apparent Power C	kVA	REAL			х	
	50	Breaker Fail Trip		DIGITAL	1			
	51	Current A	А	REAL			Х	
	52	Current A Demand	А	REAL			х	
	53	Current Avg	А	REAL			х	

# MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR

Me	diu	m Voltage Prote	ctive	e Rela	ay		
Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database
	54	Current B	А	REAL			х
	55	Current B Demand	А	REAL			х
	56	Current C	А	REAL			х
	57	Current C Demand	А	REAL			x
	58	Current G	А	REAL			x
	59	Current G Demand	А	REAL			x
	60	Current N	А	REAL			x
	61	Current Negative Sequence		REAL			x
	62	Current RMS Neutral	А	REAL			х
	63	Current RMS Phase A	А	REAL			х
	64	Current RMS Phase B	А	REAL			х
	65	Current RMS Phase C	А	REAL			х
	66	Current Unbalance	%	REAL			х
	67	Ex Trips		REAL			
	68	Frequency	Hz	REAL			
	69	LS 01	%	REAL			
	70	LS 02	%	REAL			
	71	LS 03	%	REAL			
	72	LS 04	%	REAL			
	73	Max Ambient RTD	>C	REAL	2		
	74	Max Bearing RTD	>C	REAL	2		
	75	Max Other RTD	>C	REAL	2		
	76	Max Winding RTD	>C	REAL	2		
	77	Negative Sequence Current Demand		REAL			
	78	Power Elements Trip		DIGITAL	1		
	79	Power Factor		REAL			
	80	Power Factor A		REAL			
	81	Power Factor B		REAL			
	82	Power Factor C		REAL			
	83	Reactive Energy Into the Load	kVARH	REAL			
	84	Reactive Energy Out of the Load	kVARH	REAL			
	85	Reactive Power	kVAR	REAL			
	86	Reactive Power A	kVAR	REAL			
	87	Reactive Power B	kVAR	REAL			

Me	diu	m Voltage Prote	ctive	e Rela	iy		
Device	ltem	Measurement	Unit	Point Type	Alarm Priority	Graphics	Trend Database
	88	Reactive Power C	kVAR	REAL			
	89	Relay Status		REAL		Х	
	90	Remote Trip		DIGITAL			
	91	Residual voltage V0	V	REAL			
	92	RTD 01	>C	REAL			Х
	93	RTD 02	>C	REAL			Х
	94	RTD 03	>C	REAL			Х
	95	RTD Ambient Trip		DIGITAL	1		
	96	RTD Ambient Warning		DIGITAL	2		
	97	RTD Error Trip		DIGITAL	1		
	98	RTD Other Trip		DIGITAL	2		
	99	RTD Other Warning		DIGITAL			
	100	RTD Wind Bear Trip		DIGITAL	1		
	101	RTD Wind Bear Warning		DIGITAL	2		
	102	Software Alarm		DIGITAL	3		
	103	Sync Frequency	Hz	REAL			
	104	Synchronism Check Voltage	V	REAL			
	105	Synchronism Check Voltage RMS	V	REAL			
	106	System Voltage RMS	V	REAL			
	107	Voltage A-B	v	REAL			
	108	Voltage A-N	v	REAL			
	109	Voltage B-C	v	REAL			
	110	Voltage B-N	v	REAL			
	111	Voltage C-A	v	REAL			
	112	Voltage C-N	v	REAL			
	113	Voltage L-L Avg	V	REAL			
	114	Voltage L-N Avg	V	REAL			
	115	Voltage Negative Sequence	V	REAL			
	116	Voltage RMS Phase A-B	V	REAL			
	117	Voltage RMS Phase A-N	V	REAL			
	118	Voltage RMS Phase B-C	V	REAL			
	119	Voltage RMS Phase B-N	V	REAL			
	120	Voltage RMS Phase C-A	V	REAL			
	121	Voltage RMS Phase C-N	V	REAL			

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MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR

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Medium Voltage Pro	tectiv	e Rel	ay	
Device them Manual A	11	Point	Alarm	Cuanh

	_			Point	Alarm		Trend
Device	Item	Measurement	Unit	Туре	Priority	Graphics	Database
	122	Voltage Unbalance	%	REAL			
	123	Warning		DIGITAL	2		
	124	Contact Wear A	%	REAL	3		
	125	Contact Wear B	%	REAL	3		
	126	Contact Wear C	%	REAL	3		

	99	Active Power	kW	ANALOG		Х	Х
	100	Apparent Power	kVA	ANALOG		Х	Х
	101	Current A	А	ANALOG		Х	Х
	102	Current Avg	А	ANALOG		Х	Х
	103	Current B	А	ANALOG		Х	Х
	104	Current C	А	ANALOG		Х	Х
ircuit Meter	105	Current N	А	ANALOG		Х	Х
	106	Energy Consumption High Word	kWH	ANALOG		Х	Х
	107	Energy Consumption Low Word	kWH	ANALOG			Х
	108	Over Current Alarm		DIGITAL	1		
	109	Over kVA Alarm		DIGITAL	1		
	110	Phase A Loss Alarm		DIGITAL	1		
	111	Phase B Loss Alarm		DIGITAL	1		
	112	Phase C Loss Alarm		DIGITAL	1		
O	113	Power Factor		ANALOG		Х	
<b>h</b>	114	Power Factor A		ANALOG			
C	115	Power Factor B		ANALOG			
ar	116	Power Factor C		ANALOG			
Bra	117	Reactive Power	kVAR	ANALOG		Х	
	118	Under Current Alarm		DIGITAL			
	119	Under KVA Alarm		DIGITAL			
	120	Voltage A-B	V	ANALOG		Х	
	121	Voltage A-N	V	ANALOG		Х	
	122	Voltage B-C	V	ANALOG		Х	
	123	Voltage B-N	V	ANALOG		Х	
	124	Voltage C-A	V	ANALOG		Х	

125	Voltage C-N	v	ANALOG	х	
126	Voltage L-L Avg	V	ANALOG	Х	
127	Voltage L-N Avg	V	ANALOG	Х	

# APPENDIX C: COMMISSIONING SUPPORT DURATIONS

Tests Performed	Per Unit / Per System	Duration					
I. Commissioning Level 4							
PDCS/EPMS/SCADA	Per Switchgear/Electrical	4 days each location					
System Tests:	Room Location						
<ul> <li>Connectivity and</li> </ul>							
Status Verification.							
<ul> <li>CxA defined test</li> </ul>							
scenarios.							
Protection System Tests	Per Switchgear/Electrical	2 Days each location					
	Room Location						
II. Commissioning Level 5							
Integrated System Test	Building Phase	2 Day					
(Coordination)							
Integrated System Test	Building Phase	5 Days					
(Functional)							

26 13 13







FIGURE 2: 4100 & 4500 GS PROTECTION SINGLE-LINE DIAGRAM



FIGURE 3: 4100 & 4500 TS PROTECTION SINGE-LINE DIAGRAM

END OF APPENDICES

# SECTION 26 13 23

# MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Switchgear enclosure.
    - a. Circuit breaker switchgear.
    - b. Power Transfer Configuration
    - c. Instruments.
    - d. Protective relays.
    - e. AC control power supply.
    - f. DC control power supply.
    - g. Warning labels and signs.
- B. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismicload, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
- 1.2 DEFINITIONS
  - A. ASYM: Asymmetrical.
  - B. SYM: Symmetrical.
- 1.3 ACTION SUBMITTALS
  - A. Product Data: For each type of product.
    - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
    - 2. Time-current characteristic curves for overcurrent protective devices.
  - B. Shop Drawings: For medium-voltage, metal-enclosed switchgear.
    - 1. Include a tabulation of installed devices with features and ratings.
    - 2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations must show major components, features, and mimic bus diagram.
    - 3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts.
    - 4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
    - 5. Locate accessory and spare equipment storage.
    - 6. Include single-line diagram.
    - 7. Include control power wiring diagrams.
    - 8. Include batteries, battery rack, equipment base, and room layout. MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR

- 9. Include copy of nameplate.
- 10. Ratings of the assembled switchgear:
  - a. Voltage.
  - b. Continuous current.
  - c. Short-circuit rating.
  - d. BIL.
- 11. Utility company's metering provisions with indication of approval by utility company.
- 12. Design Calculations: Signed and sealed by a qualified structural professional engineer. Calculate requirements for selecting seismic restraints.
- 13. Wiring Diagrams: For each switchgear assembly include the following:
  - a. Power, signal, and control wiring.
  - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
  - c. Schematic control diagrams.
  - d. Diagrams showing connections of component devices and equipment.
  - e. Schematic diagrams showing connections to remote devices.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For switchgear and batteries, signed by product manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Provide Seismic qualified equipment as follows:
  - 1.
  - 2. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest California Building Code (CBC) with OSHPD/HCAI Amendments. The equipment shall have OSHPD Special Seismic Certification (OSP) Pre-Approval.
  - 3. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
  - 4. The IP rating of the equipment shall be 1.5
  - 5. The Structural Engineer for the Site will evaluate the SDS values published on the OSHPD/HCAI website to ascertain that they are "equal to" or "greater than" those required for the Project Site.
  - 6. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
    - a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
    - b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
    - c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:
    - a. Potential transformer fuses.
    - b. Control power fuses.
  - 2. Spare Indicating Lights: Six of each type installed.
  - 3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.

# 1.6 WARRANTY

- A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace the switchgear control system storage batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranted Cycle Life for VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:
    - a. For discharge rate not faster than 8 hours, discharge duration not longer than 8 hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 6 discharge cycles.
    - For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
    - c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

# PART 2 - PRODUCTS

- 2.1 SYSTEM DESCRIPTION
  - A. Manufactured Unit: Metal-enclosed switchgear, designed for application in ungrounded system.
  - B. Switchgear Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.
  - C. Comply with IEEE C37.20.3.

### 2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Eaton.
- 2.3 SWITCHGEAR ENCLOSURE
  - A. Indoor Enclosure: Steel.

- B. Outdoor Enclosure: Weatherproof, galvanized steel, designed for installation outdoors. Aisleless, full-height doors, with provisions for padlocking, in front of basic weatherproof equipment. Integral structural-steel base frame with factory-applied asphaltic undercoating.
  - 1. Each vertical section must have the following features:
    - a. Structural design and anchorage adequate to resist loads imposed by 125 mph wind.
    - b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
    - c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
    - d. Weatherproof ground-fault circuit interrupter duplex receptacle.
    - e. Power for heaters and receptacles must be provided by control power transformer.
    - f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.
- C. Enclosure Finish:
  - 1. Outdoor Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

# 2.4 CIRCUIT BREAKER SWITCHGEAR

- A. Construction:
  - 1. Deadfront, metal-enclosed, drawout, arc-resistant, switchgear assembly of vertical sections, each with vacuum circuit breakers. Additional vertical sections must be provided to house accessories related to the switchboard functions.
    - a. Comply with IEEE C37.20.7, Type 2C.
    - b. Front and rear access switchgear.
    - c. Front and rear vertical section covers must have full-length hinges. The front cover must be a flanged door with latching hardware. The rear cover may be bolted.
  - 2. Bus: Silver-plated copper.
    - a. Ground Bus: Sized to carry the rated short-time withstand current, and connected to the metal enclosures of each vertical section.
  - 3. Auxiliary Vertical Sections and Compartments:
    - a. Utility metering compartment that complies with utility company requirements.
    - b. Owner's Metering: Vertical section with a front hinged door for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration or testing while the gear is energized.
- B. Surge Arresters: Comply with IEEE C62.11, distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Vacuum Circuit Breakers:
  - 1. Operated by a motor-charged, stored-energy mechanism and having manual means of charging the mechanism.
  - 2. Electrically Operated:
    - a. 120 V(ac) close, ac capacitor trip. Powered powered from a fused control transformer integral to the switchgear.

- D. Protective Relays
  - 1. Microprocessor-based, multifunction, overcurrent relay with the following IEEE C37.2 device functions:
    - a.
    - b. 51/50, 51N/50N, 50BF, 25, 32, 46, 67, 27, 59, 47, 81-O, 81-U, and 86.
- E. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.
- F. Capacities and Characteristics:
  - 1. Switchgear Assembly:
    - a. Rated Maximum Voltage and BIL: 4.76 kV, 60 kV and 15 kV, 95 kV.
    - b. Rated Continuous Current: 600 A and 1200 A.
    - c. Rated Momentary Withstand Current (600 A and 1200 A Continuous Current Ratings): 40 kA SYM RMS for 10 cycles
    - d. Rated Short-Time Withstand Current (600 A and 1200 A Continuous Current Ratings): 25 kA SYM RMS for 2 s.
  - 2. 5 kV Circuit Breaker:
    - a. Rated Continuous Current and Load Switching Current: 600 A.
    - b. Short-Circuit Current at Rated Maximum Voltage: 40 kA SYM RMS.
    - c. Closing and Latching Maximum Current: 25 kA crest.
    - d. Maximum Interrupting Current and Three-Second Rating: 65 kA SYM RMS.
    - e. Rated Interrupting Time: 5 cycles.
  - 3. 15 kV Circuit Breaker:
    - a. Rated Continuous Current and Load Switching Current: 1200 A.
    - b. Short-Circuit Current at Rated Maximum Voltage: 40 kA SYM RMS.
    - c. Closing and Latching Maximum Current: 25 kA crest.
    - d. Maximum Interrupting Current and Three-Second Rating: 65 kA SYM RMS.
    - e. Rated Interrupting Time: 5 cycles.
    - f. Special Switch Configurations:
      - 1) Two-position, no-fuse, no-load selector switch.
      - 2) Duplex switches, with a common load-side bus and a fuse on the load-side of the bus.

#### 2.5 POWER TRANSFER CONFIGURATIONS

- A. Two-Breaker Transfer Control:
  - 1. Two-breaker transfer control must provide for a switchgear assembly with a common load bus and two normally energized medium-voltage power sources, designated "normal" and "standby," connected to the load bus. The circuit breakers connecting the two power sources to the load bus must be controlled by a microprocessor-based automatic transfer control. Power for the transfer control must be from the voltage sensing transformers.
  - 2. In the automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control must automatically open the normal power source and close the standby source circuit breaker.
  - 3. Sequence of Operation:
    - a. The default operation must be with the normal source main breaker closed and the standby main breaker open. Upon detection of an undervoltage to the line side of the normal main breaker and after a fieldadjustable time delay, that main breaker must open and after an additional field-adjustable time delay, the standby breaker must close restoring power to the facility.

- b. Upon restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker must open and after a field-adjustable time delay, the normal main breaker must close.
- 4. Field-Adjustable Transfer Parameters:
  - a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range: 0 seconds to 30 minutes.
  - b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range: 0 seconds to 120 seconds.
  - c. Delay the transfer from the standby power source to the normal power source: (0 seconds to 30 minutes).
  - d. A relay with contact that changes state when the power is available on the normal source and a relay with contact that changes state when the power is available on the standby source.
- 5. Controls and Indicators: In addition to the delay setting controls, provide the following:
  - a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers tripped due to overcurrent or ground fault.
  - b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
  - c. Transfer-control automatic and manual selector.
    - 1) Interlock must prevent paralleling of the two power sources in manual mode.
  - d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
  - e. Selector to place control into programming mode.
  - f. Circuit breaker control switch for each of the normal and standby source breakers, providing open and close operation.
  - g. Push button to initiate manual retransfer to the normal source when the transfer controller is in the automatic mode.
  - h. Meters and display to show the following:
    - 1) Voltage and frequency of both sources.
    - 2) A multi-line display showing the following:
      - a) Set points of timers, and voltage pickup and dropout set points.
      - b) Date, time, and reason for at least the last 10 transfers. The display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
      - c) When the control system is in the transferring process, the display must show delay countdown in seconds.
  - i. LED lights to show the following:
    - 1) Normal source available.
    - 2) Standby source available.
    - 3) Normal source connected.
    - 4) Standby source connected.
    - 5) Load bus energized.
- 6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
- 7. Voltage Sensing Relays: Microprocessor-based IEEE device number 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.

- A. Instrument Transformers: Comply with IEEE C57.13.
  - 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 accuracy class of 0.3 with burdens of W, X, and Y.
  - 2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
- B. Multifunction Digital Meter and Monitor: Microprocessor-based unit suitable for threeor four-wire systems.
  - 1. Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
    - Switch-selectable digital display with the following features:
      - a. Phase Currents, Each Phase: Plus or minus 1 percent.
      - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      - d. Three-Phase Real Power: Plus or minus 2 percent.
      - e. Three-Phase Reactive Power: Plus or minus 2 percent.
      - f. Power Factor: Plus or minus 2 percent.
      - g. Frequency: Plus or minus 0.5 percent.
      - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
      - i. Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
  - 3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring and Control."
  - 4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

# 2.7 PROTECTIVE RELAYS

- A. Multifunctional, solid-state microprocessor-based relay systems complying with IEEE C37.90.
- B. Relay Mounting:
  - 1. Each relay must be mounted in a drawout case with a two-stage quick-release operation.
  - 2. Removal of the relay from the case must disconnect the trip circuits and short the current-transformer secondaries before the unit control power is disconnected.
  - 3. When the relay is inserted into the case, control power connections must be made before the trip circuits are activated.
  - 4. Include a self-shorting contact on the case terminal block for alarm indication and tripping of circuit breaker upon removal of the relay from the case.
- C. Equip each relay system with a communications module to transmit the following data in accordance with Section 260913 "Electrical Power Monitoring and Control."
  - 1. Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.
  - 2. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is configured in remote open-close mode.
- D. Overcurrent and Ground-Fault Protective Relays:

- 1. IEEE C37.2 Device Functions: 51/50 and 51/50N.
- 2. Field-Selectable Relay Settings: Required by the overcurrent protective device coordination study and arc-flash study.
- 3. Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.
- 4. Phase and Ground Protection: Field-selectable curves from IEEE moderately inverse, very inverse, or extremely inverse.
- 5. Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when the breaker is being closed and must be deactivated after approximately eight cycles.
- 6. Contacts:
  - a. Two Form-A contacts.
  - b. Field selectable into contact pairs as follows and as required by the overcurrent protective device coordination study and arc-flash study:
    - 1) One contact assigned ANSI 51 phase and ANSI 51 ground, and the other contact assigned ANSI 50 phase and ANSI 50 ground.
    - 2) One contact assigned ANSI 51/50 phase, and the other contact assigned 51/50 ground.
- 7. Alphameric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:
  - a. Individual phase currents.
  - b. Ground current.
  - c. Cause of trip.
  - d. Magnitude and phase of current-causing trip.
  - e. Phase or ground indication.
  - f. Peak current demand for each phase and ground since last reset.
  - g. Current-transformer primary rating.
  - h. Programmed phase and ground set points.
- 8. Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. Provide a "protection off" alarm, which must be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay must be de-energized, providing a fail-safe protection off alarm.

### 2.8 AC CONTROL POWER SUPPLY

- A. Description:
  - 1. Uninterruptible ac power supply complying with requirements in Section 263353 "Static Uninterruptible Power Supply."

### 2.9 DC CONTROL POWER SUPPLY

- A. Description: Dedicated 48 V(dc) battery system.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. C&D Technologies, Inc.
  - 2. EnerSys.
  - 3. Trojan Battery Company.

- C. System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 77 deg F with electrolyte at normal level and minimum ambient temperature of 55 deg F. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.
- D. Battery:
  - 1. Standard VRLA batteries, with system disconnect and overcurrent protective device.
  - 2. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Rate battery rack, cell supports, and anchorage for seismic requirements.
  - 3. Accessories:
    - a. Thermometers with specific-gravity correction scales.
    - b. Hydrometer syringes.
    - c. Set of cell numerals.
  - 4. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.
    - a. DC ammeter.
    - b. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
    - c. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.
    - d. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
    - e. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.
    - f. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.
    - g. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.
    - h. Charger's Audible Noise: Less than 26 dB.
- E. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
- F. Control Wiring: Factory installed, complete with bundling, lacing, and protection.
  - 1. Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for No. 8 AWG and smaller.
  - 2. Conductors: Sized in accordance with NFPA 70 for duty required.

#### 2.10 CONTROL NETWORK

A. Compliance with ASHRAE 135: Controllers must support serial MS/TP and Ethernet IP communications and must be able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

#### 2.11 WARNING LABELS AND SIGNS

- A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
  - 1. Warning signs must be baked enamel signs.
  - 2. Equipment Identification Labels: Laminated acrylic or melamine label.

#### 2.12 SOURCE QUALITY CONTROL

- A. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.20.3:
  - 1. Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
  - 2. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
  - 3. Perform the control wiring dielectric test at 1500 V for one minute.
- B. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.20.4.
  - 1. Perform mechanical operation tests to ensure proper functioning of the switch.
  - 2. Verify the contact gap. Perform terminal-to-terminal resistance test.
  - 3. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
  - 4. Perform the control wiring dielectric test at 1500 V for one minute.
- C. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.
  - 1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
  - 2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
  - 3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
  - 4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and shop drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
  - 5. Unload switchgear, observing packing label warnings and handling instructions. MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR

- 6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
  - 1. Handle switchgear in accordance with manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
  - 2. Protect switchgear compartments against the entrance of dust, rain, and snow.
  - 3. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
  - 4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
  - 5. Do not damage structure when handling switchgear.
- C. Storage:
  - 1. Store switchgear in a location that is clean and protected from weather. Protect switchgear from dirt, water, contamination, and physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
  - 2. Store switchgear with compartment doors closed.
  - 3. Regularly inspect switchgear while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions.
- D. Examine roughing-in of conduits and grounding systems to verify the following:
  - 1. Wiring entries comply with layout requirements.
  - 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.
- E. Pre-Installation Checks:
  - 1. Verify removal of any shipping bracing after placement.
- F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 ohms at switchgear location.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION OF SWITCHGEAR

- A. Equipment Mounting:
  - 1. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Switchgear must be installed level and plumb. Switchgear must tilt less than 1.5 degrees while energized.
- C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's written instructions and NFPA 70.
- D. Comply with NECA 430.

### 3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Grounding Connections at Interior Locations:
  - 1. Install bare copper cable not smaller than No. 4/0 AWG for grounding to grounding electrodes.
  - 2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors.
  - 3. Keep leads as short as practicable with no kinks or sharp bends.
  - 4. Make joints in grounding conductors and loops by exothermic weld or compression connector.
- C. Grounding Connections at Exterior Locations:
  - 1. Install tinned bare copper cable not smaller than No. 4/0 AWG, for counterpoise buried not less than 30 inch below grade interconnecting the grounding electrodes.
  - 2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown.
  - 3. Keep lead lengths as short as practicable with no kinks or sharp bends.
  - 4. Fence and equipment connections must not be smaller than No. 4 AWG.
  - 5. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft..
  - 6. Bond each gate section to the fence post using 1/8 by 1 inch [**tinned**]flexible braided copper strap and clamps.
  - 7. Make joints in grounding conductors and loops by exothermic weld or compression connector.
- D. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.
- E. Complete switchgear grounding and lightning arrester connections prior to making any other electrical connections.
- F. Terminate medium-voltage cables in accordance with Section 260513 "Medium-Voltage Cables."

#### 3.4 SIGNS AND LABELS

- A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
- B. Install warning signs as required to comply with OSHA in 29 CFR 1910.269.

#### 3.5 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. General Field Testing Requirements:
  - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods."
  - 2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

- 3. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
- C. Medium-Voltage Switchgear Assembly Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Verify that fuse and circuit breaker sizes and types correspond to Drawings and coordination study, as well as to the circuit breaker's address in the control network.
    - b. Verify that current and voltage transformer ratios correspond to Drawings.
    - c. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
      - 1) Attempt closure on locked-open devices. Attempt to open lockedclosed devices.
      - 2) Make key exchange with devices operated in off-normal positions.
    - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    - f. Inspect insulators for evidence of physical damage or contaminated surfaces.
    - g. Verify correct barrier and shutter installation and operation.
    - h. Exercise active components.
    - i. Inspect mechanical indicating devices for correct operation.
    - j. Verify that filters are in place and vents are clear.
    - k. Perform visual and mechanical inspection of instrument transformers in accordance with Article "Instrument Transformer Field Tests."
    - I. Inspect control power transformers.
      - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
      - 2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.
      - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
  - 2. Electrical Tests:
    - a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - b. Perform dc voltage insulation-resistance tests on each bus section, phase to phase and phase to ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
      - Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.

- 2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
- c. Perform a dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.
  - If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
- d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
  - 1) Minimum insulation-resistance values of control wiring must not be less than two megohms.
- e. Control Power Transformers:
  - Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground. Insulationresistance values of winding insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
  - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
  - 3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
  - 4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.
- f. Voltage Transformers:
  - 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
  - 2) Verify secondary voltages by energizing the primary winding with system voltage.
- g. Perform current-injection tests on the entire current circuit in each section of switchgear.
  - 1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
  - 2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
- h. Perform system function tests in accordance with "System Function Tests" Article.
- i. Verify operation of space heaters.
- j. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.
- D. Medium-Voltage Vacuum Circuit Breaker Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.

- b. Inspect anchorage, alignment, grounding, and required clearances.
- c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.
- d. Verify the unit is clean.
- e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
- f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism must be in accordance with manufacturer's published data.
- g. Verify cell fit and element alignment.
- h. Verify racking mechanism operation.
- i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- k. Perform time-travel analysis. Travel and velocity values must be in accordance with manufacturer's published data.
- I. Record as-found and as-left operation counter reading. Operation counter must advance one digit per close-open cycle.
- 2. Electrical Tests:
  - a. Perform insulation-resistance tests for one minute on each pole, phaseto-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
  - b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range in accordance with manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.
  - d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer's published data.
  - e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
  - f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.

- g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.
- h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
- i. Verify operation of heaters.
- E. Instrument Transformer Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Verify that equipment nameplate data complies with Contract Documents.
    - b. Inspect physical and mechanical condition.
    - c. Verify correct connection of transformers with system requirements.
    - d. Verify that adequate clearances exist between primary and secondary circuit wiring.
    - e. Verify the unit is clean.
    - f. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - g. Verify that required grounding and shorting connections provide contact.
    - h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
    - i. Verify correct primary and secondary fuse sizes for voltage transformers.
    - j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
  - 2. Electrical Tests of Current Transformers:
    - a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
    - c. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
    - d. Perform a ratio-verification test using the voltage or current method in accordance with IEEE C57.13.1. Ratio errors must be in accordance with IEEE C57.13.
    - e. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match the curve supplied by the manufacturer or be in accordance with IEEE C57.13.1.

- f. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. Measured burdens must be compared with and must match instrument transformer ratings.
- g. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages must be in accordance with Table 100.5.
- h. Perform dielectric withstand tests on the primary winding with the secondary grounded. Test voltages must be in accordance with Table 100.9.
- i. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
- j. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.
- 3. Electrical Tests of Voltage Transformers:
  - a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. Perform insulation-resistance tests winding-to-winding and each winding to ground. Test voltages must be applied for one minute in accordance with Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
  - c. Perform a polarity test on each transformer to verify the polarity marks or H1- X1 relationship as applicable. Polarity results must agree with transformer markings.
  - d. Perform a turns-ratio test on all tap positions. Ratio errors must be in accordance with IEEE C57.13.
  - e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared with and must match instrument transformer ratings.
  - f. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. The dielectric voltage must be in accordance with Table 100.9. The test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.
  - g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipationfactor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
  - h. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. Test results must indicate that the circuits are grounded at only one point.
- F. Ground Resistance Test:
  - 1. Visual and Mechanical Inspection:
    - a. Verify ground system complies with the Contract Documents and NFPA 70 Article 250, "Grounding and Bonding."
    - b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.

- c. Inspect bolted electrical connections using a calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- d. Inspect anchorage.
- 2. Electrical Tests:
  - a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than 5 ohms.
  - b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with Contract Documents.
  - c. Inspect physical and mechanical condition.
  - d. Inspect bolted electrical connections for high resistance using a lowresistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- G. Metering Devices Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
    - c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
    - d. Verify the unit is clean.
    - e. Verify freedom of movement, end play, and alignment of rotating disk(s).
  - 2. Electrical Tests:
    - a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - b. Verify accuracy of meters at all cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
    - c. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
    - d. Verify all instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
    - e. Verify that current transformer and voltage transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.
- H. Medium-Voltage Surge Arrester Field Tests:
  - Visual and Mechanical Inspection:
    - a. Verify that equipment nameplate data complies with Contract Documents.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, grounding, and clearances.

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- d. Verify the arresters are clean.
- e. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
- f. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.
- 2. Electrical Test:
  - a. Perform an insulation-resistance test on each arrester, phase terminal to ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
  - b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
  - c. Test grounding connections. Resistance between the arrester ground terminal and the ground system must be less than 0.5 ohm.
- I. Microprocessor-Based Protective Relay Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
    - b. Verify operation of light-emitting diodes, display, and targets.
    - c. Record passwords for each access level.
    - d. Clean the front panel and remove foreign material from the case.
    - e. Check tightness of connections.
    - f. Verify that the frame is grounded in accordance with manufacturer's instructions.
    - g. Set the relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
    - h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.
  - 2. Electrical Tests:
    - a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
    - b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
    - c. Functional Operation: Check functional operation of each element used in the protection scheme as follows:
      - 1) Timing Relay:
        - a) Determine time delay.
        - b) Verify operation of instantaneous contacts.
      - 2) Volts/Hertz Relay:
        - a) Determine pickup frequency at rated voltage.
        - b) Determine pickup frequency at a second voltage level.
        - c) Determine time delay.
      - 3) Sync Check Relay:
        - a) Determine closing zone at rated voltage.
        - b) Determine maximum voltage differential that permits closing at zero degrees.
        - c) Determine live line, live bus, dead line, and dead bus set points.
        - d) Determine time delay.
        - e) Verify dead bus/live line, dead line/live bus, and dead bus/dead line control functions.
      - 4) Undervoltage Relay:

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- a) Determine dropout voltage.
- b) Determine time delay.
- c) Determine time delay at a second point on the timing curve for inverse time relays.
- 5) Directional Power Relay:
  - a) Determine minimum pickup at maximum torque angle.
  - b) Determine closing zone.
  - c) Determine maximum torque angle.
  - d) Determine time delay.
  - e) Verify time delay at a second point on the timing curve for inverse time relays.
  - f) Plot the operating characteristic.
- 6) Current Balance Relay:
  - a) Determine pickup of each unit.
  - b) Determine percent slope.
  - c) Determine time delay.
- 7) Negative Sequence Current Relay:
  - a) Determine negative sequence alarm level.
  - b) Determine negative sequence minimum trip level.
  - c) Determine maximum time delay.
  - d) Verify two points on the I-two-squared-t curve.
- 8) Phase Sequence or Phase Balance Voltage Relay:
  - a) Determine positive sequence voltage to close the NO contact.
  - b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
  - c) Verify negative sequence trip.
  - d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
  - e) Determine time delay to close the NC contact upon removal of voltage when previously set to rated system voltage.
- 9) Instantaneous Overcurrent Relay:
  - a) Determine pickup.
  - b) Determine dropout.
  - c) Determine time delay.
- 10) Time Overcurrent:
  - a) Determine minimum pickup.
  - b) Determine time delay at two points on the time current curve.
- 11) Ground Detector Relay:
  - a) Determine maximum impedance to ground causing relay pickup.
- 12) Directional Overcurrent Relay:
  - a) Determine directional unit minimum pickup at maximum torque angle.
  - b) Determine closing zone.
  - c) Determine maximum torque angle.
  - d) Plot operating characteristics.
  - e) Determine overcurrent unit pickup.
  - f) Determine overcurrent unit time delay at two points on the time current curve.
- d. Control Verification:
  - 1) Functional Tests:
    - a) Check operation of all active digital inputs.
    - b) Check output contacts or silicone-controlled rectifiers (SCRs), preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.

MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR

- c) Check internal logic functions used in protection scheme.
- d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.
- 2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.
- J. DC System VRLA Batteries Field Test:
  - 1. Visual and Mechanical Inspection:
    - a. Verify that batteries are adequately located.
    - b. Verify that battery area ventilation system is operable.
    - c. Verify existence of suitable eyewash equipment.
    - d. Verify equipment nameplate data complies with Contract Documents.
    - e. Inspect physical and mechanical condition.
    - f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
    - g. Verify the units are clean.
    - h. Inspect spill containment installation.
    - i. Verify application of an oxide inhibitor on battery terminal connections.
  - 2. Electrical Tests:
    - a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
    - b. Verify charger functions and that alarms comply with system manufacturer's recommendations.
    - c. Measure negative post temperature. Negative post temperature must comply with manufacturer's published data or IEEE 1188.
    - d. Measure charger float and equalizing voltage levels. Charger float and equalizing voltage levels must be in accordance with the battery manufacturer's published data.
    - e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.
    - f. Measure intercell connection resistances.
    - g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
    - h. Perform a load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass the test.
    - i. Measure the battery system voltage from positive to ground and negative to ground. Voltage measured from positive to ground must be equal in magnitude to the voltage measured from negative to ground.

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- K. Nonconforming Work:
  - 1. Switchgear will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- L. Prepare test and inspection reports. Record as-left set points of adjustable devices.

# 3.6 SYSTEM FUNCTION TESTS

- A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
  - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.

# 3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, if requested by Owner, perform the following voltage monitoring:
  - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
  - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
    - a. Adjust switchgear taps.
    - b. Prepare written request for voltage adjustment by electric utility.
  - 3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
  - 4. Report:
    - a. Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection.
  - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.
  - 2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1deg C at 86 deg F.
  - 3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and lists the results as follows:
    - a. Description of equipment to be tested.
    - b. Discrepancies.
    - c. Temperature difference between the area of concern and the reference area.
    - d. Probable cause of temperature difference.
    - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    - f. Identify load conditions at time of inspection.
    - g. Provide photographs and thermograms of the deficient area.
  - 4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

# END OF SECTION

# SECTION 26 22 13

## LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.
- B. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismicload, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

## 1.2 ACTION SUBMITTALS

- A. Data:
  - 1. For each type of product.
    - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
    - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.
  - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

- C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Business.
  - 2. Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - 3. Eaton.
  - 4. MGM Transformer Company.
  - 5. Prolec GE; A Xignux and General Electric Company Joint Venture.
  - 6. Siemens Industry, Inc., Energy Management Division.
  - 7. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

# 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

# 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
  - 1. One leg per phase.
  - 2. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Coil Material: Aluminum.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Welded.

- D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
  - 1. Core and coil must be encapsulated within resin compound using vacuumpressure impregnation process to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
  - 4. Environmental Protection:
    - a. Indoor: UL 50E, Type 2.
  - 5. Outdoor: UL 50E, Type 3R.
    - a. Finish Color: ANSI 49 gray weather-resistant enamel.
- F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.
- K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- L. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.
  - 1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
  - 2. Indicate value of K-factor on transformer nameplate.
  - 3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.
- M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
  - 1. 9.00 kVA and Less: 40 dB(A-weighted).
  - 2. 9.01 to 30.00 kVA: 45 dB(A-weighted).
  - 3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9 48 dB(A-weighted) for K-factors of 13 and 20.
  - 4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9 53 dB(A-weighted) for K-factors of 13 and 20.
  - 5. 150.01 to 300.00 kVA: 55 dB(A-weighted) for K-factors of 1, 4, and 9. LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

6. 300.01 to 500.00 kVA: 60 dB(A-weighted) for K-factors of 1, 4, and 9.

## 2.4 IDENTIFICATION

- A. Nameplates:
  - 1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

# 2.5 SOURCE QUALITY CONTROL

- A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.
  - 1. Resistance measurements of windings at rated voltage connections and at tap connections.
  - 2. Ratio tests at rated voltage connections and at tap connections.
  - 3. Phase relation and polarity tests at rated voltage connections.
  - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
  - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
  - 6. Applied and induced tensile tests.
  - 7. Regulation and efficiency at rated load and voltage.
  - 8. Insulation-Resistance Tests:
  - a. Line-side to ground.
  - 9. Load-side to ground.
  - 10. Line-side to load-side.
    - a. Temperature tests.
  - 11. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- B. Nonconforming Work:
  - 1. System equipment that does not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

# PART 3 - EXECUTION

- 3.1 EXAMINATION
  - A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
  - B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
  - C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
  - D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5  $\Omega$  at location of transformer.

- E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

# 3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

# 3.4 FIELD QUALITY CONTROL

1.

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
  - Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:
    - a. Visual and Mechanical Inspection.
      - 1) Inspect physical and mechanical condition.
  - 2. Inspect anchorage, alignment, and grounding.

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- 3. Verify that resilient mounts are free and that shipping brackets have been removed.
- 4. Verify that unit is clean.
- 5. Perform specific inspections and mechanical tests recommended by manufacturer.
- 6. Verify that as-left tap connections are as specified.
- 7. Verify presence of surge arresters and that their ratings are as specified.
  - a. Electrical Tests:
    - 1) Measure resistance at windings, taps, and bolted connections.
    - 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
    - 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
    - 4) Verify correct secondary voltage, phase-to-phase and phase-toneutral, after energization and prior to loading.
- B. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.
- C. Nonconforming Work:
  - 1. Transformer will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Assemble and submit test and inspection reports.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

# 3.5 ADJUSTING

- A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare written report recording output voltages and tap settings.

# 3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

#### 3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

- 1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
- 2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
- 3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

# END OF SECTION

# SECTION 26 24 13

## SWITCHBOARDS

#### 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. Service and distribution switchboards rated 600 V and less.
  - 2. Surge suppression devices.
  - 3. Disconnecting and overcurrent protective devices.
  - 4. Instrumentation.
  - 5. Control power.
  - 6. Accessory components and features.
- 1.3 DEFINITIONS
  - A. ATS: Acceptance testing specification.
  - B. GFEP: Ground-fault equipment protection.
  - C. MCCB: Molded-case circuit breaker.
  - D. SPD: Surge protective device.
- 1.4 ACTION SUBMITTALS
  - A. Product Data: Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - B. Shop Drawings: For each switchboard and related equipment.
    - 1. Detail enclosure types for types other than NEMA 250, Type 1.
    - 2. Detail bus configuration, current, and voltage ratings.
    - 3. Detail short-circuit current rating of switchboards and overcurrent protective devices.
    - 4. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
    - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
    - 6. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
    - 7. Include schematic and wiring diagrams for power, signal, and control wiring.

# 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. Include the following:
  - 1. Routine maintenance requirements for switchboards and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
  - 4. Circuit directories with load descriptions in electronic format.

# 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two spares for each type of panelboard cabinet lock.
- 1.7 QUALITY ASSURANCE
  - A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
  - B. Use of series rated equipment is prohibited.
- 1.8 DELIVERY, STORAGE, AND HANDLING
  - A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
  - B. Remove loose packing and flammable materials from inside switchboards; install temporary electric heating (250 W per section) to prevent condensation.
  - C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 2, usual service conditions.
- 1.10 COORDINATION
  - A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels. Coordinate work so that piping, ducts etc. are routed around dedicated spaces above and in front of switchboards per code.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

# 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Switchboard Warranty Period: Five years from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
  - 1. SPD Warranty Period: Five years from date of Substantial Completion.

# PART 2 - PRODUCTS

- 2.1 SWITCHBOARDS
  - A. Manufacturers:
    - 1. Eaton Electrical, Inc.
    - 2. Square D.
    - 3. ABB.
  - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by UL and marked for intended locations and application.
  - C. Comply with NEMA PB 2.
  - D. Comply with NFPA 70.
  - E. Comply with UL 891.
  - F. Front-Accessible Switchboards:
    - 1. Fixed, individually mounted.
    - 2. Branch Devices: Panel Mounted.
    - 3. Section Alignment: Front aligned.
  - G. Nominal System Voltage: As indicated.
  - H. Main-Bus Continuous: As indicated.
  - I. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Seismic Control".
  - J. Outdoor Enclosures: Type 3R.
    - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
    - 2. Enclosure: Flat roof; rear hinged doors for each section, with provisions for padlocking.
    - 3. Factory installed electric heater, with integral thermostat and disconnect to maintain minimum interior temperature of 40 deg F.
    - 4. Factory installed exhaust fan with integral thermostat and disconnect to maintain maximum temperature of 100 deg F.

- 5. 120V, 20A, Maintenance duplex receptacle, GFCI type.
- 6. Include control power transformer for space heaters, ventilation, and receptacle.
- K. Barriers: Between adjacent switchboard sections.
- L. Insulation and isolation for main and vertical buses of feeder sections.
- M. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
- N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- O. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
  - 2. Phase- and Neutral-Bus Material:
    - a. Hard-drawn copper of 98 percent conductivity. Silver plated
  - 3. Copper feeder circuit-breaker line connections.
  - 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.
  - 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - 6. Disconnect Links:
    - a. Isolate neutral bus from incoming neutral conductors.
    - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
  - 7. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  - 8. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
  - 9. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

# 2.2 SURGE PROTECTIVE DEVICES

- A. Manufacturer: Same manufacturer as switchboard.
- B. Listed and labeled in accordance with UL 1449.
- C. Features and Accessories:
  - 1. Integrals disconnect switch.
  - 2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
  - 3. Redundant suppression circuits.
  - 4. Redundant replaceable modules.
  - 5. Indicator light display for protection status.

- 6. Form-C contacts rated at 5 A and 250 V(ac), one normally open and one normally closed, for remote monitoring of protection status.
- 7. Surge counter.
- D. Peak Single-Impulse Surge Current Rating: 120 KA per mode/240 KA per phase.
- E. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 KA), 8-by-20mic.sec. surges with less than 5 percent change in clamping voltage.
- F. Protection Modes and UL 1449 SVR for grounded wye circuits with 480/277-V, three-phase, four-wire circuits shall be as follows:
  - 1. Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120.
  - 2. Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
  - 3. Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
- G. SCCR: Rated at 200-KA interrupting capacity.
- 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES
  - A. Manufactured by and Listed for use in switchboard being furnished.
  - B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
    - 1. Thermal-Magnetic Circuit Breakers:
      - a. Inverse time-current element for low-level overloads.
      - b. Instantaneous magnetic trip element for short circuits.
      - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
    - 3. Electronic Trip Circuit Breakers:
      - a. RMS sensing.
      - b. Field-replaceable rating plug or electronic trip.
      - c. Digital display of settings, trip targets, and indicated metering displays.
      - d. Multi-button keypad to access programmable functions and monitored data.
      - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
      - f. Integral test jack for connection to portable test set or laptop computer.
      - g. Field-Adjustable Settings:
        - 1) Instantaneous trip.
          - 2) Long- and short-time pickup levels.
          - 3) Long and short time adjustments.
          - 4) Ground-fault pickup level, time delay, and I squared T response.
    - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; letthrough ratings less than NEMA FU 1, RK-5.
    - 5. Subfeed Circuit Breakers: Vertically mounted.
    - 6. MCCB Features and Accessories:
      - a. Standard frame sizes, trip ratings, and number of poles.
      - b. Breaker handle indicates tripped status.

- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- h. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- i. Multipole units enclosed in a single housing with a single handle.
- j. Handle Padlocking Device: Fixed attachment, for locking circuitbreaker handle in off position.
- k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
  - 1. Fixed circuit-breaker mounting.
  - 2. Two-step, stored-energy closing.
  - 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
  - 4. Instantaneous trip.
  - 5. Time adjustments for long- and short-time pickup.
  - 6. Ground-fault pickup level, time delay, and I squared t response.
  - 7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - 8. Remote trip indication and control.
- 2.4 INSTRUMENTATION
  - A. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

# 2.5 IDENTIFICATION

- A. Switchboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the enclosure.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside enclosure door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.
  - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
  - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
  - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
  - 4. Install temporary heating during storage in accordance with manufacturer's published instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- 3.3 INSTALLATION
  - A. Comply with manufacturer's published instructions.
  - B. Reference Standards:
    - 1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
    - 2. Consult Architect for resolution of conflicting requirements.
  - C. Special Techniques:

1

- Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."
  - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
  - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to switchboards.

- e. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
- 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- 3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- 4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- 5. Install filler plates in unused spaces of panel-mounted sections.
- 6. Install overcurrent protective devices, surge protection devices, and instrumentation.
- 7. Set field-adjustable switches and circuit-breaker trip ranges.

# 3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit.
  - 2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 5. Perform the following infrared scan tests and inspections, and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove [front] [front and rear] panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Nonconforming Work:
  - 1. Switchboard will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

# 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

#### 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

# END OF SECTION

# SECTION 26 24 16

#### PANELBOARDS

#### 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. Distribution panelboards
  - 2. Lighting and appliance branch-circuit panelboards

#### 1.3 DEFINITIONS

- A. ATS: Acceptance testing specification
- B. GFCI: Ground-fault circuit interrupter
- C. GFEP: Ground-fault equipment protection
- D. MCCB: Molded-case circuit breaker
- E. SPD: Surge protective device
- F. VPR: Voltage protection rating

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

- 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
- 4. Detail bus configuration, current, and voltage ratings.
- 5. Short-circuit current rating of panelboards and overcurrent protective devices.
- 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 7. Include wiring diagrams for power, signal, and control wiring.
- 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

# 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. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

# 1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

# 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.10 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
  - 3. Comply with NFPA 70E.

#### 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
  - 1. SPD Warranty Period: Five years from date of Substantial Completion.

# PART 2 – PRODUCTS

#### 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. 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.
- C. Comply with NEMA PB 1
- D. Comply with NFPA 70
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1
    - b. Outdoor Locations : NEMA 250, Type 3R
    - c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
  - 2. Height: 84 inches maximum
  - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  - 4. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel
- F. Incoming Mains:
  - 1. Location: Bottom
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity

- a. Plating shall run entire length of bus
- b. Bus shall be fully rated the entire length.
- 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
- 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity
  - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
  - 6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 7. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: 15 percent

- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
  - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards rated above 240 V and less than 600 V shall have shortcircuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

# 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Furnish panelboards with OSHPD OSP Special Seismic Certificate.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

# 2.3 POWER PANELBOARDS

- A. Manufacturers:
  - 1. General Electric Type CCB, or equivalent product from Square D, Siemens, or Eaton.
- B. Panelboards: NEMA PB 1, distribution type
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches <Insert dimension> high, provide two latches, keyed alike.
- D. Mains: Circuit breaker

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers:
  - 1. 120/208 volt:
    - a. General Electric Type AL, or equivalent product from Square D, Siemens, or Eaton.
  - 2. 277/480 volt:
    - a. General Electric Type AE, or equivalent product from Square D, Siemens, or Eaton.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

# 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufactured by and Listed for use in Panelboard being furnished.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads
    - b. Instantaneous magnetic trip element for short circuits
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic Trip Circuit Breakers:

- a. RMS sensing
- b. Field-replaceable rating plug or electronic trip
- c. Digital display of settings, trip targets, and indicated metering displays.
- d. Multi-button keypad to access programmable functions and monitored data.
- e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
- f. Integral test jack for connection to portable test set or laptop computer.
- g. Field-Adjustable Settings:
  - 1) Instantaneous trip
  - 2) Long- and short-time pickup levels
  - 3) Long and short time adjustments
  - 4) Ground-fault pickup level, time delay, and I squared T response
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; letthrough ratings less than NEMA FU 1, RK-5.
- 5. Subfeed Circuit Breakers: Vertically mounted
- 6. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles
  - b. Breaker handle indicates tripped status
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- h. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- i. Multipole units enclosed in a single housing with a single handle.
- j. Handle Padlocking Device: Fixed attachment, for locking circuitbreaker handle in off position.
- k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

### 2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

# 2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

#### PART 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1
- C. Install panelboards and accessories according to NEMA PB 1.1
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 84 inch above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- N. Mount spare fuse cabinet in accessible location.

## 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

## 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for lowvoltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

# 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

# 3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

# SECTION 26 27 26

## WIRING DEVICES

### 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. Standard-grade receptacles, 125 V, 20 A.
- 2. GFCI receptacles, 125 V, 20 A.
- 3. Toggle switches, 120/277 V, 20 A.
- 4. Wall plates.

## 1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter
- B. BAS: Building automation system
- C. EMI: Electromagnetic interference
- D. GFCI: Ground-fault circuit interrupter
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor
- F. RFI: Radio-frequency interference
- G. SPD: Surge protective device

#### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product

#### PART 2 - PRODUCTS

# 2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70
- C. RoHS compliant
- D. Comply with NEMA WD 1
- E. Device Color:

- 1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
- 2. Wiring Devices Connected to Essential Electrical System: Red.
- F. Wall Plate Color: For plastic covers, match device color.
- G. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
  - 1. Description: Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498 and FS W-C-596.
- B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:
  - 1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498 and FS W-C-596.
  - 4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

## 2.3 GFCI RECEPTACLES, 125 V, 20 A

- A. Duplex GFCI Receptacles, 125 V, 20 A:
  - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Type: Non-feed through.
  - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
- B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:
  - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Type: Non-feed through.
  - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
  - 5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

# 2.4 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Single-Pole Switches, 120/277 V, 20 A:
  - 1. Standards: Comply with UL 20 and FS W-S-896.
- B. Two-Pole Switches, 120/277 V, 20 A:
  - 1. Comply with UL 20 and FS W-S-896.
- 2.5 WALL PLATES
  - A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

- B. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

- 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
- 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
- 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
- 8. Tighten unused terminal screws on the device.
- 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  - 1. Install ground pin of vertically mounted receptacles up.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

# 3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

# 3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

# 3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
  - 1. In healthcare facilities, prepare reports that comply with NFPA 99.
  - 2. Test Instruments: Use instruments that comply with UL 1436.
  - 3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
- 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
- 3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
- 4. Using the test plug, verify that the device and its outlet box are securely mounted.
- 5. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

# END OF SECTION

## SECTION 26 28 13

#### FUSES

#### 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. Cartridge fuses rated 600 V ac and less for use in the following:
    - a. Control circuits.
    - b. Motor-control centers.
    - c. Panelboards.
    - d. Switchboards.
    - e. Enclosed controllers.
    - f. Enclosed switches.
    - Spare-fuse cabinets.

#### 1.3 ACTION SUBMITTALS

2.

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Coordination charts and tables and related data.

#### 1.4 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
  - A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

## 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  - 2. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- B. 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Class RK-1: Up to 600A.
  - 2. Class L: Over 600A.
  - 3. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

## 3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

## 3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse

replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

# END OF SECTION

## SECTION 26 28 16

## ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.
- 1.4 ACTION SUBMITTALS
  - A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
    - 1. Enclosure types and details for types other than NEMA 250, Type 1.
    - 2. Current and voltage ratings.
    - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

- 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
- 1.7 FIELD CONDITIONS
  - A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
    - 2. Altitude: Not exceeding 6600 feet.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with NFPA 70.

## 2.3 FUSIBLE SWITCHES

- A. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three pole.
  - 3. 600-V ac.
  - 4. 1200 A and smaller.
  - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
  - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- B. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 6. Service-Rated Switches: Labeled for use as service equipment.

## 2.4 NONFUSIBLE SWITCHES

- A. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- B. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 6. Service-Rated Switches: Labeled for use as service equipment.

#### 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

## PART 3 - EXECUTION

- 3.1 EXAMINATION
  - A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

## 3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Owner's written permission.
  - 4. Comply with NFPA 70E.

## 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

## 3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

#### 3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - i. Verify correct phase barrier installation.
    - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
  - 1. Test procedures used.
  - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  - 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- 3.7 ADJUSTING
  - A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

# END OF SECTION

# SECTION 26 32 13

## MEDIUM VOLTAGE DIESEL-ENGINE-DRIVEN GENERATOR SETS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section includes all labor, materials, equipment and services necessary for and incidental to design, furnishing, factory testing, delivery, unloading, installation, field testing, training and documentation of newly manufactured Medium Voltage Diesel-Engine-Driven Generator sets as shown on the Drawings and specified herein.
- B. The Diesel-Engine Driven Generator sets shall work together with the Medium Voltage Switchgear and the Medium Voltage Power Distribution Control System (PDCS) Suppliers and deliver an integrated Medium Voltage power system.
- C. The Supplier shall not be required to provide the following:
  - 1. Buildings, foundations, or mounting framework.
  - 2. Cable raceways, interconnecting cabling, wiring and materials external to the enclosures of equipment specified herein, except that which connects to the DFP/SCR Emissions system on the roof of the enclosure.
  - 3. Piping external to the equipment specified herein, except that which connects to the DFP/SCR Emissions system on the roof of the enclosure.
  - 4. Secondary switchgear
  - 5. Labor and rigging for unloading and installation.
  - 6. Electrical energy and/or fuel for site testing.
- D. Scope demarcation, Interfaces and liaisons are listed in the table below. See Specification 01 42 16 for definitions of the terms used in the table.

Responsibility	Medium Voltage Diesel-Engine- Driven Generator Sets	MV PDCS Supplier	MV Circuit Breaker Switchgear Supplier	General Contractor	Cx Agent
Coordination	Provide	Provide	Provide	Provide	Provide
MV Controls Integration	Coordinate interfaces, provide information to PDCS and MV Switchgear Suppliers and support integration into their systems	Provide	Provide information, coordinate Interfaces	Provide and Manage	Oversee
MV Diesel-Engine- Driven Generator Sets Complete Package	Provide	Interface and Integrate controls	Interface	Provide and Manage	Oversee
MV Diesel-Engine- Driven Generator Sets Offloading and positioning on site	Provide	n/a	n/a	Provide and Manage	n/a

Responsibility	Medium Voltage Diesel-Engine- Driven Generator Sets	MV PDCS Supplier	MV Circuit Breaker Switchgear Supplier	General Contractor	Cx Agent
MV Diesel-Engine- Driven Generator Sets Installation and Connections	Support	Support controls part	Support interfaces	Provide	n/a
Level 1 Commissioning: Factory Acceptance Test	Provide	n/a	n/a	Provide and Manage	Witness
Level 2 Commissioning: Field Installation Verification and Construction Tests	Support	n/a	n/a	Provide	Observe and Review Reports
Level 3 Commissioning: MV Diesel-Engine- Driven Generator Sets Functional Testing and Startup	Provide	Support and verify integration	Support	Provide and Manage	Support and Review Reports
Level 3 Commissioning: PDCS and Integration Testing	Support	Provide	Support	Provide and Manage	Support and Review Reports
Level 4 Commissioning: Functional System Testing	Support	Support	Support	Support	Provide
Level 5 Commissioning: Integrated System Testing	Support	Support	Support	Support	Provide
As built drawings, Operations and Maintenance Manuals	Provide	n/a	n/a	Provide	Oversee
Staff Training	Provide	n/a	n/a	Provide	Oversee

## 1.2 REFERENCES

- A. Standards, Codes and Guides
  - 1. Global Standards
    - a. International Organization for Standardization (ISO) Standards:
      - 1) ISO 3046 Standard for Reciprocating Internal Combustion Engines Performance.

- 2) ISO 8178-1 Reciprocating Internal Combustion Engines Exhaust Emissions Measurement
- 3) ISO 8528 Standard for reciprocating internal combustion engine driven alternating current generator sets.
- 4) ISO 9001 Quality Management Systems. Requirements
- 5) ISO 10005 Quality Management Systems. Guidelines for Quality Plans
- 6) ISO 12944 Paints and varnishes Corrosion protection of steel structures by protective paint systems
- 7) ISO 20340 Paints and varnishes Performance requirements for protective paint systems for offshore and related structures
- b. Standards of International Code Council (ICC)
  - 1) International Building Code (IBC)
  - 2) ICC AC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
- 2. Additional standards for sites in North America:
  - a. National Fire Protection Association
    - 1) NFPA 37 Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines
    - 2) NFPA 70 National Electrical Code.
    - 3) NFPA 101 Life Safety Code.
    - 4) NFPA 110 Standard for Emergency and Standby Power Systems.
  - b. Relevant standards of the National Electrical Manufacturers Association (NEMA), in particular:
    - 1) ANSI/NEMA MG-1 Standard for Motors and Generators.
    - 2) ANSI/NEMA MG-2 Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.
  - c. Relevant standards of the American National Standards Institute (ANSI), in particular:
    - 1) ANSI C2 The National Electrical Safety Code
  - d. Relevant standards of the Institute of Electrical and Electronics Engineers (IEEE).
    - 1) IEEE 115 Guide for Test Procedures for Synchronous Machines
    - 2) IEEE 141 Recommended Practices for Electric Power Distribution for Industrial Plants
    - IEEE 386 Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V
    - 4) IEEE 446 Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
  - e. Relevant standards of the International Society of Automation (ISA).

- 1) ANSI/ISA-71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
- f. Relevant standards of the American Society of Mechanical Engineers (ASME).
  - 1) Boiler and Pressure Vessel Code
- g. Relevant standards of the American Society of Testing and Materials (ASTM).
  - 1) D 3951 Standard Practice for Commercial Packaging
- h. Relevant standards of the American Petroleum Institute (API).
  - 1) API STD 650 Welded Steel Tanks for Oil Storage
- i. Relevant Standards of The American Society of Civil Engineers (ASCE)
  - 1) ISCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
- j. Relevant Underwriters Laboratories Inc. (UL) Safety Standards:
  - 1) UL142 Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
  - 2) UL2085 Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids
  - 3) UL508 Standard for Safety Industrial Control Equipment
- k. US Environmental Protection Agency
  - 1) 40 CFR 60 Standards of Performance for New Stationary Sources
  - 2) 40 CFR 89 Control of Emissions from New and In-Use Non-road Compression-Ignition Engines
- I. Standards applicable to Outdoor enclosures, intakes and louvers, SCR exhausts and any other outdoor items
  - 1) TAS-201 Large Missile Impact Test (ASTM E1996),
  - 2) TAS-202 Uniform Static Pressure Test (ASTM330)
  - 3) TAS-203 Cyclic Wind Pressure Test
- B. Compliance with requirements of the authority having jurisdiction (A.H.J.) shall also be included, if A.H.J. requirements affect the manufacturing of the equipment.
- C. Project Contract Documents
  - 1. Drawings: Wherever the terms "Plans" or "Drawings" are used in these specifications, they shall refer to the Issued for Construction Drawings for this project. The equipment proposed to be furnished under these specifications shall be compatible with the space provisions, wiring configurations and other requirements shown on these Drawings.
  - 2. Specifications: Other Contract specifications and documents contain information related to the equipment and services specified herein. Some are listed below:
    - a. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
    - b. Division 26

- 1) 26 05 00 Common Work Results for Electrical, set of specifications
- 2) 26 09 16 Power Distribution Control System
- 3) 26 13 13 Medium-Voltage Circuit Breaker Switchgear
- 4) 26 33 23 Central Battery System (Station Service)
- 3. Sketches and supporting materials attached to this package and part of the IFC set including: single lines; protection details; station battery DC schematics; cable requirements; replacement strategy and others.
- D. Equipment submittals from other Suppliers.

#### 1.3 SYSTEM DESCRIPTION DESIGN AND PERFORMANCE REQUIREMENTS

- A. The diesel-engine-driven generator sets, and the associated components specified herein shall be integrated into a single package from a single manufacturer with responsibility for entire package installation and performance. All emission controls, instrumentation, protection devices, operational devices, controls, interlocks, and spare equipment as specified herein or as required to provide a safe, dependable, and properly functioning backup power system shall be provided.
- B. The equipment supplied shall be of a proven design with durable materials that can meet the requirements specified and build in accordance with the latest applicable standards and for the ambient conditions of the project site using historical worst-case max/ min data.
- C. Workmanship shall be of the best quality, free from any defects that might render the equipment unreliable, unsuitable, or inefficient. Best quality practices should be documented and followed, verification of these procedures should be provided to the Owner, if requested. The enclosure, engine, generator, and all accessories shall be level and true. Attachments shall be consistent and mounted parallel and plumb to the units, enclosure and to other attachments. Rust prone metal shall be protected against corrosion with heavy duty coatings, resistant to water, and splash or spillage of diesel, oil and other petroleum products. Painting, cleanliness, and finish shall be of the highest quality and shall visibly demonstrate the expertise of the manufacturer.
- D. Limiting Physical Dimensions. Please refer to the project layout drawings for details of limiting dimensions. The dimensions indicated on the drawings indicate the space allowances available and shall not be exceeded. Any non-conformance with the dimensions shown shall be identified by the Supplier at the time of Bid. Any costs associated with size changes after contract award shall be borne by the Supplier. The physical dimensions shall not limit the maintainability of the equipment. The Supplier shall also consider the delivery logistics, including dimensions and weight constraints for shipment of equipment and components to the project site. Components considering the overall weight and dimensions may be shipped separately to ensure compliance with local shipping requirements.
- E. The System shall be capable of powering critical and non-critical loads as described herein. The System shall operate continuously in the event of a utility outage and during other events and activities such as storm anticipation, maintenance and failure recovery, and generator system testing and maintenance activities.
- F. The transition from and to the utility may occur as open transition or momentary closed transition (100ms maximum).

- G. The generators are arranged for N+1 operation. The maximum number of generators operating in parallel on any Bus is provided in Appendix A. The system shall be capable of starting, paralleling at least two units and accepting load within 10 seconds of a start request.
- H. The engine, its systems, all hoses, seals, gaskets and fuel filters shall be capable of running on renewable diesel (HVO) and B20 biodiesel fuel with.
- I. Fuel and DEF terminals shall be located as close to the north driveway, as possible, to allow for convenient and easy refilling.
- J. Fire Protection. The engine generator set, fuel system, and controls shall be inherently designed to prevent the occurrence of fire.
- K. Seismic-Restraint Design: Enclosures, engine-generator assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces. Additional local requirements shall be for the specific project location, Specifications Section 01 81 16 Facility Environmental Data and Section 26 05 48 Vibration and Seismic Controls for Electrical Equipment, where 26 05 48 provided.
- L. Nomenclature and Identification. Follow the latest revision of Specification 01 42 09 Nomenclature and Identification for document identification, labeling cabling, equipment and components. The Supplier shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation in accordance with the Owner's requirements. All information shall be provided in electronic format to be approved by the Engineer.
- M. Safety
  - 1. Rotating parts shall be guarded against accidental contact.
  - 2. Use of the materials and chemicals known to damage the environment and be detrimental to human health is prohibited. Materials include, but are not limited to: polychlorinated biphenyl (PCB), asbestos, know carcinogenic substances, etc.
- N. Maintainability. The Supplier shall incorporate the following maintainability design concepts:
  - 1. Equipment and accessories specified herein shall be designed for a life expectancy of 30 years as a minimum.
  - 2. Full life cycle costs shall be considered including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified herein.
  - 3. Materials shall be selected to provide corrosion- and wear-resistance protection that is adequate for the environment and service. Should a material not be replaceable with a corrosion resistant one, the susceptibility shall be mitigated with coatings as appropriate for the environment as described in this specification.
  - 4. The equipment shall be able to be moved via a pallet in order to minimize the need to utilize excessive manpower or cranes for maintenance..
  - 5. Components likely to require replacement during emergency repairs shall be readily accessible and marked. Such components shall be mounted so they can be easily pulled-out and/or connected by quick disconnect fittings. Test points or terminals for maintenance shall be included.
  - 6. Electronic components shall be protected against power fluctuations and electrical discharges.

- 7. The need to conduct periodic physical inspections shall be minimized, and equipment status and condition shall, in as far as it is practical, be remotely monitored.
- 8. Where checking of the health and status of working equipment is necessary, the Supplier shall incorporate methods of inspection compliant with applicable safety codes. Owner's requirements and that can be accommodated without the need to power-down the equipment under inspection and / or the location from where the inspection is to be undertaken.
- 9. The equipment shall be arranged so that all routine test and maintenance inspections can be automated or carried out from ground level, catwalks at a safe distance and away from rotating and hazardous components.
- Recalibration and cleaning requirements shall be minimized. 10.
- О. Interfaces shall be provided as required to connect gauges, sensors, instruments and intelligent to the paralleling system (PDCS) and remote monitoring system.
- Ρ. The design shall pay special attention to the environmental impact due to possible breakdowns or failures and shall include measures to mitigate their impact. This shall consider equipment reliability and probability of failure, as well as economic mitigation costs.

#### 1.4 INTEGRATED POWER SYSTEM

- Α. The equipment supplied herein shall interface with equipment from other Suppliers to form a fully integrated, functional, resilient and concurrently maintainable power system. The Supplier shall liaise with the other equipment Suppliers to coordinate the interface with their systems, provide necessary technical information and ensure a fully integrated power system.
- B. The engine-generator Supplier and the PDCS Supplier shall coordinate the required electrical and control interfaces, equipment locations, dimensions as required for an integrated and complete backup generation package. Coordinate equipment provided by one supplier needed to be installed by another supplier.
- C. The Supplier and the MV Switchgear supplier shall coordinate the required electrical and protection interfaces, equipment locations, dimensions as required for an integrated and fully protected backup generation package. Coordinate equipment provided by one supplier needed to be installed by another supplier.
- D. The Supplier shall be responsible for coordination with the Contractor, Engineer, and Cx Agent for scheduling all delivery, testing and construction administration activities as required for the entire equipment order.
- E. The Engine Generator Supplier and Switchgear Supplier shall assist the PDCS Supplier in the development of factory and site testing procedure requirements and control circuitry connections required between the PDCS, Switchgear and the engine generators.

#### 1.5 SUBMITTALS

- General Α.
  - 1. Languages. English.
  - 2. All drawings and data shall be identified by the Owner's project name, job location, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each

drawing shall be made by such means as a triangle-enclosed revision number. Drawings shall be stamped/sealed by a registered professional engineer as required for the local jurisdiction.

- 3. Nomenclature and Identification. The Suppliers shall identify and code all the supplied cabling, equipment, component, parts, drawings and documentation in accordance with the Owner's requirements. All information shall be provided in electronic format to be approved by the Engineer.
- 4. CAD Standards. The Owner will provide CAD guidelines to be followed during the development of the shop drawings.
- 5. Electronic format.
  - a. File names shall be intuitive and clearly identify the document.
  - b. All documents are required to be provided as ISO Portable Data Format (PDF) files.
- 6. All conflicts and discrepancies between the requirements of this Specification, Drawings, codes and standards and Purchase Order shall be referred to Engineer and the Owner for clarification before proceeding with the manufacturing of the affected parts.
- B. Submittal. Following the requirements herein, as a minimum, provide the information listed below in electronic format in English language. Failure to submit this information shall cause the submittal to be rejected as non-responsive.
  - 1. Technical Offer:
    - a. A narrative describing the proposed solution including any value engineering or alternative cost options.
    - b. Itemized Specification compliance response. The response shall include a copy of these Specifications, including all Appendices with each paragraph noted with the comment, "C" for Compliance, "D" for Deviation, and "E" for Exception. Additionally, a filled in Numbers or Excel spreadsheet shall be provided listing the paragraphs noted with deviation or exception and providing additional detail on the scope and reasons for the deviation/exception. Failure to submit this information with the bid shall cause the submital to be rejected as non-responsive. The definition of these terms appears below:
      - 1) "C": By stating "compliance", the Supplier agrees to furnish the item or the feature as specified with no variation.
      - 2) "D": By stating "deviation", the Supplier proposes to furnish the item or the feature in a different way, while still meeting or exceeding the intended purpose of the product. The Manufacturer shall describe the reason for the deviation and the advantages/disadvantages of the proposed solution. Deviation should clearly reference specification section and line item. Stating deviation does not mean or imply acceptance.
      - 3) "E": By stating "exception", the Supplier's intention is not to furnish the item, the feature or the services specified. The Manufacturer shall describe the reason for the exception. Exemption should clearly reference specification section and line item. Stating exception does not mean or imply acceptance.

- 4) If nothing is stated, it is assumed that the Supplier states "compliance". If there are contradictions in the statements, it is assumed that the statement that favors the Owner takes precedence.
- c. Product design data and catalog data, including, but not limited to:
  - 1) Parameters listed in Appendix A this specification
  - 2) Engine type, size, cylinders.
  - 3) Engine fuel consumption requirements.
  - 4) Generator frame size and insulation class.
  - 5) Generator steady state, transient and subtransient: X/R, resistance and reactance.
  - 6) Generator fault current for 3-phase symmetrical and single-phase ground faults.
  - 7) Engine-Generator set dimensions and weights.
  - 8) Engine-Generator set power ratings (ESP, LTP, PRP and COP Ratings).
  - 9) Engine-Generator and radiator heat rejection.
  - 10) Engine-Generator and radiator aspiration and cooling air flow requirements.
  - 11) Engine NOX and CO emissions (lbs/hr, ppm) at 25%, 50%, 75%, and 100% load (with and without emissions control system).
  - 12) Voltage regulator (if provided with EG).
  - 13) Engine governor (if provided with EG).
  - 14) Fuel oil base tank (UL 142).
  - 15) Emissions control system.
  - 16) Integral diesel exhaust fluid (DEF) tank.
  - 17) Vapor recovery system.
  - 18) Radiator.
  - 19) Starting batteries and chargers.
  - 20) Best Battery Selector (Diode assembly).
  - 21) Vibration isolators.
  - 22) Neutral Grounding Resistor (NGR) device.
- d. Drawings
  - 1) Dimensions, weight, clearances, orientation, and other relevant physical data.
  - 2) Plan layouts clearly identifying each piece of equipment, dimensions and clearances. The plan layout must show the equipment supplied per these Specifications and their arrangement within the enclosure.

- 3) Elevations showing dimensions of Engine-Generator and supplied optional items.
- 4) A three-line diagram clearly indicating the protective and metering components on the equipment.
- Bill of materials. e.
- f Sub-suppliers/Manufacturers of all major components.
- Manufacturing Locations: g.
  - 1) Engine
  - 2) Generator
  - 3) Final packaging
- Preliminary Instruction Manual for Installation. h.
- Declaration of Conformity and product certifications. i.
- Supporting product information necessary to understand the technical j. solution.
- 2. Shipping plan
- 3 Lead time
  - Shop Drawings/Prior-to-Fabrication Submittal sent to Owner (calendar days a. after contract award)
  - b. Delivery of equipment (calendar days after approval of Fabrication by Owner), for each shipment batch.
- 4. Maintenance
  - Recommended extra materials and spare parts, including pricing. a.
  - Maintenance schedule, including pricing for annual cost of service. b.
- Any additional requirements from the Owner's Procurement Team 5.
- C. Shop Drawings
  - Supplier's preliminary drawings and bill of materials for long lead items shall be 1. submitted by the Seller to the Owner for approval within 14 days of issuance of a purchase order prior to proceeding with any fabrication or assembly of equipment.
  - 2. Supplier's final manufacturing drawings and bill of materials shall be submitted by the Seller to the Owner for approval within 45 days of issuance of a purchase order prior to proceeding with any assembly of equipment. The Owner reserves the right to make changes in requirements until the Supplier's drawings are returned approved.
  - 3. All drawings and data shall be identified by the Purchaser's project ID, job location, Purchaser's purchase order number, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each drawing shall be made by such means as a triangle-enclosed revision number. The following items as a minimum are required.
    - a. Outline drawings showing plan and elevation views of each piece of equipment, and containing the size, weight, center of gravity and heat dissipation for each item:
    - b. Base plans for required support pad and the location of equipment anchor bolts.
    - Support pedestal details showing integral fuel tank. C.
    - Emissions controls system including urea tank and pump skid with fill port d. locations.

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- e. Fuel and urea ports shall be provided with easily accessible connections on exterior of enclosure.
- f. Plans showing location of power, controls and communications cable entrances, fuel piping Provide and return connections, and emissions system urea piping connections.
- g. Three-line wiring diagrams, showing unit provisions for feeder connections, grounding points, and all control and protection connections.
- h. Detailed schematic diagrams and product descriptions of associated protective instrumentation.
- i. Engine mounted instrumentation and control panel details.
- D. The shop drawings shall include product description and data sheets for the following items:
  - a. Generator voltage regulator data, mounting and wiring details.
  - b. Engine governor/load sharing control details and mounting requirements.
  - c. Vibration isolator details, including anchor bolt or hanger size requirements.
  - d. Battery, battery rack, battery charger, and diode isolator data and installation details. Emissions control system equipment and control panels.
  - e. Fully integral emission control system equipment and control panels.
  - f. Complete mechanical and electrical technical data on engine, generator and radiator including, but not limited to, the following:
    - 1) Generator manufacturer, frame size and insulation class
    - 2) Engine type, compression ratio, cylinders and displacement.
    - 3) Electrical time constants and reactance values.
    - 4) Radiator model and air flow requirements.
  - g. Engineering Performance data sheets describing the following:
    - 1) Engine horsepower and torque.
    - 2) Generator power and temperature ratings.
    - 3) Fuel consumption rates at 1/4, 1/2, 3/4 and full load (based on recommended fuel type and standard operating conditions).
    - 4) Ventilation and combustion air requirements.
    - 5) Exhaust system flow rates and backpressure requirements.
    - 6) Emissions tables
    - 7) Heat rejection from engine, generator, radiator and exhaust.
    - 8) Transient response characteristics to block load changes of 25 percent, 50 percent, 75 percent and 100 percent.
    - 9) Maximum motor starting capabilities.
    - 10) Maximum short circuit current for a 3 phase and ground faults.
    - 11) Noise levels from engine, radiator and exhaust.
    - 12) Generator efficiency @ 50 percent, 75 percent and 100 percent load.
    - 13) Generator "Type test" for:
      - a) Rated capacitive load Performance.

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- b) Maximum load test with purely capacitive load for generator permissive operation.
- h. Engine-Generator system lubricating oil and coolant capacities.
- i. Fuel oil, lubricating oil and coolant type requirements.
- j. Fuel, air and oil filter type requirements.
- k. Engine emissions data (as required for EG permitting in the state where units are to be installed) listed in pounds per hour and kilograms per hour at half and full load for all relevant pollutants.
- 2. Manufacturer's and Supplier's written warranty.
- 3. The shop drawings shall include plan and elevation drawings of the Engine-Generator outdoor enclosure showing the location of all items associated with the unit including:
  - a. Fuel oil base tank integrated into support frame.
  - b. Auxiliary power panel.
  - c. Starting batteries and chargers.
  - d. Intake and exhaust airways with required duct silencing.
  - e. Access doorways and required steps/platforms.
  - f. Emissions control equipment and control panel if applicable.
  - g. Neutral Grounding Resistor (NGR) device.
- 4. The shop drawings shall be accompanied with the following certifications and procedures:
  - a. Provide Seismic certification specifying the exact method of anchoring the equipment to withstand seismic forces in the seismic zone described in Specification Section 018116 Environmental Requirements.
  - b. Factory acceptance test procedures.
  - c. Certified copies of factory acceptance test results (immediately after completion of tests).
  - d. Site acceptance test procedures for approval.
  - e. Recommended preventative maintenance procedure (outline form).
- 5. Seismic and anchoring detail drawings shall be submitted with the seal of a registered engineer engaged by the Supplier.
- 6. Installation, maintenance and operating instructions
  - a. The Supplier shall submit for approval to the Owner two (2) preliminary sets of installation, operating, and maintenance instructions, not necessarily bound. The Supplier shall submit the installation portion of the manuals no later than 30-days after the Owner issues a purchase order for the equipment. Operating and maintenance instructions, and any other information to be included in the manuals, shall be submitted no later than 30-days after the equipment has been shipped.
  - b. Before final acceptance of the equipment by the Owner, the Supplier shall submit to the Owner six (6) complete, bound copies and one (1) electronic copy in PDF format of the installation, operation, and maintenance instructions for each item of equipment furnished. All final instructions shall be certified by the Supplier, as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. One set of instructions, certified by the Supplier, shall be packed and sent with the equipment to the site.
  - c. Installation, maintenance and operating instruction manuals shall include, but not be limited to, the following items:

- 1) Detailed operating instructions including sequences of operation in all modes of operation. The instructions should include equipment photos, graphics and other visual help to clearly identify the equipment and appurtenances to be operated.
- 2) Detailed maintenance instructions, with recommended maintenance schedule. The instructions should include equipment photos, graphics and other visual help to clearly identify the equipment and appurtenances to be maintained.
- 3) All approved shop drawing information as called for above in "SHOP DRAWINGS" modified as appropriate for "As-Built" record data.
- 4) Typical sectional views showing mounting details of equipment and auxiliary devices, including special seismic requirements.
- 5) Specifications of all replaceable mechanical components.
- 6) Complete wiring diagrams showing all terminal markings and connections for other circuits.
- 7) Complete parts list with all principal parts identified as to manufacturer and type or model number.
- 8) Certified copies of completed factory and site testing reports.
- d. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications
  - 1. Supplier and any sub-suppliers must be regularly engaged in the manufacturing of diesel engine-generator components of the type hereinafter specified and must have similar sets in successful operation for a minimum of five (5) years.
  - 2. The Supplier shall have an authorized service center in the region capable of providing training, parts, and emergency maintenance repairs within a response period of less than twenty-four (24) hours from time of notification.
- B. The Supplier shall establish and maintain procedures for:
  - 1. Qualification/certification of field service specialists and technicians.
  - 2. Escalation of field service problems to Manufacturer's engineering support when required to back up field service personnel.
  - 3. Document and provide firmware, configuration and application software version control for the supplied intelligent devices.
  - 4. Spare parts inventory control.
  - 5. Customer notification of Manufacturer's equipment upgrades and product service alert bulletins.
- C. Supervising Specialist Qualifications
  - 1. The specialist shall be authorized by the Manufacturer to supervise and direct installation of the supplied equipment.
  - 2. The specialist shall be familiar with the equipment, Manufacturer's installation instructions and applicable safety requirements.
- D. Testing Specialist Qualifications.

- 1. The specialist shall be authorized by the Manufacturer to perform testing, start up and commissioning of the supplied equipment.
- 2. The specialist shall be familiar with the equipment, the instruction manuals and test procedure.
- 3. The specialist shall have the required certifications and have experience in testing of installations of similar size and with similar components used.
- E. Conformity and compliance. Electrical Components, Devices, and Accessories shall be certified, listed and marked as follows:
  - 1. USA: Where applicable, Certification from Nationally Recognized Testing Laboratory (NRTL).
- F. The Supplier shall participate in coordination meetings to ensure understanding of functional and installation requirements impacting the design and coordinate project sequencing and scheduling.
- 1.7 DELIVERY, STORAGE, AND HANDLING
  - A. The Supplier shall perform logistics analysis, survey shipping routes and site access to ensure safe and on time delivery to the project site(s). The Supplier shall be responsible for compliance with local trucking and delivery laws and requirements.
  - B. Identify shipment with Company's purchase order number, Owner project name, and unit/tag number, following the project naming convention.
  - C. Ship all equipment properly packed in tightly sealed, heavy gauge plastic or other type of liquid proof cover to protect the equipment from damage caused by handling, shipping, shock, vibration, corrosion, rain, dust, water, and other foreign material.
  - D. Sensitive to the environment equipment shipped separately or as a part of a bigger assembly shall be sealed and protected for any physical or environmental degradation or damage during shipping and storage.
  - E. When assemblies are supplied that require disassembly for installation or are shipped disassembled, each piece of the subassembly so affected will be uniquely identified as to its assembly position.
  - F. Box, crate or otherwise completely enclose and protect any loose components and spare parts. Clearly mark all equipment and provide complete installation instructions for any parts shipped separately from the main assembly.
  - G. Adequately brace each shipping unit and its components, both internally and externally to prevent damage during shipping, handling, storage or in the process of erection. When shipping engine driven fans, generators, etc. with the shafts connected provide braces and stiffeners to avoid shaft damage.
  - H. Clearly mark all shipping blocks, binding, braces, supports, etc. so that removal is assured. Identify any special precautions that must be observed when removing shipping constraints.
  - I. Provide all shipping units with provisions for lifting and or skidding into place. Clearly mark all lifting points.
  - J. Furnish unique installation materials and tools where required for the installation and commissioning of the equipment.
  - K. Ship equipment via direct dedicated carrier to job site. Coordinate the delivery with the Contractor and the Installing contractor with proper notifications for status of delivery.

Installing contractor will be responsible for unloading and placing equipment at its final location under the Manufacturer's supervision.

- L. The shipment shall be insured. The Supplier shall be responsible for the repair or replacement at their expense of all damage due to improper preparation, packing or damage while in transport.
- M. The Contractor shall be responsible for receiving, inspecting and storing the equipment until installation. The specified equipment shall be kept dry and clean at all times. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

## 1.8 SITE CONDITIONS

A. The supplied equipment and systems shall be designed for the site conditions. See Specification 01 81 16 Facility Environmental Data for site data and environmental conditions.

#### 1.9 SEQUENCING AND SCHEDULING

- A. The Supplier shall be responsible to coordinate production, testing and delivery schedule with the Contractor, Engineer, Commissioning Authority and the Owner to ensure ontime delivery of the equipment coordinated with the project construction schedule. The Supplier shall provide regular schedule updates and notifications for potential schedule delays.
- B. The Contractor shall provide up to date construction schedules to the Supplier on a regular basis and on a monthly basis as a minimum.

#### 1.10 WARRANTY

- A. The Supplier shall guarantee that the equipment supplied is a proven design and can meet the requirements set forth in these specifications. Workmanship shall be of the best quality, free from any defects that might render the equipment unsuitable or inefficient for the purpose for which it is to be used. In the event of problems or malfunctions, the Supplier shall have available qualified technicians capable of Providing all necessary repairs and restoring the system to full operation within four (4) hours of notification. During the first 12 months of commercial operation (as defined below), there shall be no cost to the Owner for corrective repairs, including expenses incurred for parts, factory or field labor, shipping or travel.
- B. If at any time during the first 12 months of commercial operation as defined below, the Owner shall accumulate sufficient evidence to reasonably indicate that the equipment or any part thereof is not in accordance with the specifications, the Owner will so notify the Supplier in writing, and the Supplier shall repair or replace the defective components. The cost of removal, reinstallation and complete retesting of the equipment, and any associated freight charges or service engineering charges shall be at the Supplier's expense. The guarantee for the repaired or replaced equipment shall be extended for one (1) year from the completion of repairs or replacement.
- C. If the equipment fails to meet the specific Performance guarantees, the Supplier shall recommend to the Owner adjustments or modification. Upon approval by the Owner, the adjustments or modifications shall be made, and tests shall be rerun. The cost of these adjustments or modifications and complete retesting shall be made at the Supplier's expense. After such adjustments or modifications, should the equipment fail to achieve

the guaranteed Performance, an equitable settlement shall be made which may, without limitation, include an adjustment of the contract price.

- D. Complete retesting, as referred to in this section, shall mean site acceptance testing as stipulated in testing portions of this specification. The conditions which apply to original testing requirements shall also apply to the retesting of any equipment provided under the conditions of this guarantee.
- E. Commercial operation is defined as commencing on the date on which the equipment covered by these specifications has successfully completed final site acceptance testing.
- F. In addition to certifying and warrantying that each diesel Engine-Generator set supplied will meet applicable local environmental codes and requirements. Suitable evidence will be supplied in the Supplier proposal package to demonstrate this is the case. This includes submitting the engine technical data sheets, nominal emissions versus load, not to exceed values of emissions versus load (if available), agency certificate(s) conformance letter received applicable to each make and model that is to be supplied, and the emissions test results submitted to the agency. Manufacturers that cannot meet environmental requirements without add-on pollution controls shall include such add-on controls to each diesel Engine-Generator set supplied. For all such add-on controls, the appropriate data shall be supplied. This data includes, but is not limited to, device Performance characteristics, materials of construction, dimensions, weights, effects on diesel Engine-Generator set Performance, warranties, and maintenance and testing requirements. Compliance shall be as follows:
  - 1. USA. As a minimum US EPA regulations: 40 CFR 60.4202, 40 CFR 60.4203, 40 CFR 60.4212(c), 40 CFR 89.105 and 40 CFR 89.115.

## 1.11 SYSTEM TESTING, START UP AND COMMISSIONING

- A. Prototyping. Where requested by the Owner, the Supplier shall be responsible for packaging a prototype unit and witness-testing the unit at the packager's facility.
- B. Level 1 Factory Tests
  - 1. Factory Acceptance Test (FAT)
    - a. In addition to the specified herein factory tests, the Supplier is responsible for developing and implementing any additional tests to ensure that the supplied equipment conforms to codes, standards and Owner's equipment specification.
    - b. The testing shall encompass any third-party equipment integrated into the product and supplied by the Supplier.
    - c. Interfaces for the integration into other systems including PDCS and remote monitoring, shall be tested and verified.
  - 2. Factory Witnessed Test (FWT)
    - a. The Owner and/or its representatives, the Engineer and the Commissioning Agent may witness in person the final factory acceptance test. Do not include any costs in the bid for this unlikely FWT.
    - b. If Owner decided to do FWT then the equipment shall be scheduled on the factory floor, prepared and pretested to minimize any idle time.
- C. Level 2 Equipment Installation
  - 1. The General Contractor (GC) shall have processes and perform verifications to ensure the equipment is received, stored, installed and made ready for testing.
  - 2. The GC shall employ a testing agency to perform tests conforming to ANSI/NETA ATS requirements and any additional pre-energization tests.

- D. Level 3a Supplier Startup the equipment Supplier shall have procedures and methods and perform testing to ensure the supplied equipment is started, adjusted and performance is validated on site.
- E. Level 3b Paralleling System Startup the PDCS Supplier will start up and test the paralleling system and the integration of the supplied under this specification equipment. The Supplier shall support the PDCS Supplier to ensure the supplied equipment is integrated and performs as a system.
- F. Level 4 Equipment Specific Commissioning The Owner CxA shall direct the commissioning test with the assistance and support of the GC and the Supplier to validate that the installed system conforms to the requirements.
- G. Level 5 Integrated System Testing The Owner CxA shall develop tests that ensure multiple systems, subsystems and components work as integrated systems for the whole project. The GC and Supplier(s) shall assist and support these tests.
- H. The Owner CxA will review test reports, partially or completely witness tests performed by other entities and validate completion of the required of each level tests and verifications. The GC and Supplier cannot proceed with the next level without authorization/tagging of the pertinent equipment.

## 1.12 MAINTENANCE

- A. Extra Materials and Spare Parts
  - 1. Manufacturer to develop list of recommended extra materials and spare parts. List to include per unit pricing.
- B. Maintenance Service
  - 1. Manufacturer to develop recommended maintenance schedule and procedure with detailed instructions. Include optional pricing for annual cost of service.

# PART 2 - PRODUCTS

- 2.1 RATINGS
  - A. See Appendix A for detailed service conditions and ratings data.
  - B. Nonlinear Load Performance: Performance shall be unaffected by voltage distortion caused by nonlinear load. System shall be capable of supporting up to 100 percent non-linear load and delivery of reliable operation loaded up to 100 percent of full load kW rating. Nonlinear loads include but are not limited to: IGBT-based UPS systems; Variable Frequency Drives, LED lighting and other equipment. The effects of such loads shall in no way prevent the operation of the system as specified herein. If special filtering of voltage sensing/regulating devices is found to be required to prevent load characteristics from adversely affecting operation of the Engine-Generator after installation, the filters shall be installed at no extra charge.
  - C. Steady-State Frequency Stability: When the system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady- state operational band and no hunting or surging of speed.
  - D. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple and 5 percent line-to-line. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

- E. Transient Overspeed Response: During recovery from transients caused by step load increase or step load decrease, or resulting from 100 percent load rejection, the speed of the diesel generator shall not reach the over-speed shutdown set point.
- F. Parallel Engine Generators:
  - 1. Multiple generators operating in parallel shall be capable of either isochronous or droop load sharing and shall share real and reactive load equally within ± 5 percent.
  - 2. Automatic reactive output power control and load sharing between generator sets operated in parallel. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
  - 3. Paralleling suppressors to protect excitation systems.

## 2.2 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. The generator shall be a synchronous, brushless, revolving field type with a direct connected rotating brushless exciter. Comply with NEMA MG 1.
- B. Construction and Bearings
  - 1. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
  - 2. Sub-transient direct axis reactance (X"D): 15% maximum at nominal voltage.
  - 3. The generator shall be self-ventilated and shall have a one piece, cast aluminum alloy internal fan.
  - 4. Thermal Performance: All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105°C to provide additional allowance for internal hot spots. Ambient temperature as specified in Specification 01 81 16 Facility Environmental Requirements.
  - 5. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
  - 6. Independent dual bearing design close-coupled alternator to engine.
  - 7. Bearings shall be pre-lubricated, shielded, cartridge ball bearings with provisions for adding and/or changing grease through grease pipes extended to the generator exterior.
  - 8. Minimum B-10 bearing life shall be 40,000 hours.
  - 9. Provide a minimum of one three wire 100-ohm platinum resistance temperature detectors (RTD's) on each bearing for remote temperature indication and over-temperature alarm connected to unit's control panel.
- C. Stator
  - 1. The stator windings shall be form-wound design. The output terminals shall be properly designated to identify the proper sequence. The stator shall be heavy duty construction with solid bars, heavy bands, rings and welded foot assembly. Provide six leads for differential protection.
  - 2. Provide at least six 100-ohm platinum RTD's, two per phase, embedded in the stator windings to monitor and alarm for high temperature. RTD's shall be connected to the unit's control panel.
  - 3. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
  - 4. 120V Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

- D. Rotor
  - 1. The main rotating field core shall be constructed of one piece four pole laminations. The amortisseur winding and field pole coil supports shall be integrally die-cast with the rotor laminations to form a single piece rotor core. The rotor core shall be press fit and keyed to the shaft.
  - 2. Drive: The rotor shall be directly coupled to the engine flywheel through a semiflexible shear type coupling containing replaceable shear pins or approved equal. Exciter shall be rotated integrally with generator rotor.
  - 3. The rotor windings shall be braced to withstand the forces resulting from operation at 125% overspeed and dynamically balanced.
- E. Instrument Transformers: Housed in Control and power switchgear
- F. PMG Excitation System
  - 1. The generator shall utilize a rotating field, brushless construction using a permanent magnet. Voltage regulator control power at each generator shall be from a voltage transformer at the generator or the two 24-volt batteries via a best battery selector.
- G. Voltage Regulator
  - 1. The voltage regulator shall be digital type, microprocessor based, using non-aging silicon-controlled rectifiers. The voltage regulator shall be designed to work with the permanent magnet exciter to support a fault current of at least 300% of rated value for up to 10 seconds and prevent SCR induced interference to the voltage regulation system. The voltage regulator shall be three phase sensing and shall have volts-per-hertz operation, loss of sensing, over and under excitation protection, short circuit current limit and zero droop regulation. Adjustments for voltage droop and voltage gain shall be provided. The voltage regulator shall be furnished with the generator and installed in the automatic transfer switchgear (ATSG).
  - 2. The voltage regulator shall be equipped to shut down excitation upon opening of a customer's remote contact.
  - 3. The voltage regulator shall be capable of lowering excitation for 0.5 pf leading conditions so that nominal generator voltage does not exceed 1.05 PU.
  - 4. The voltage regulator shall maintain the specified steady-state operational band with a non-linear load having a THD of not more than 15%.
  - 5. Reverse Power (Watt and VAR) Relay Activation Point monitors generator output power and initiates a shutdown of the unit if a reverse power condition is detected.
  - 6. Regulation: +0.25% no load to full load.
  - 7. Regulator temperature drift: Less than 0.5% for any 40°C change over the operating temperature range.
  - 8. Programmable Volts/Hz characteristic: Two slope ranges adjustable form 1 to 10 V/Hz.
  - 9. Regulator response time: Maximum of 10 milliseconds.
  - 10. Regulator sensing: True RMS 3-phase sensing is standard. Variable sense range.
  - 11. Regulator stability: Regulator responds to the fundamental component of the sensed voltage and remains stable for total harmonic distortion of the generator output volt-age waveform up to 20%.
  - 12. Fine voltage adjustment range: -10% to 10% of regular sensing voltage.
  - 13. Regulator voltage gain (IR compensation): Adjustable 0-10%.

- 14. Fault detection and identification: Diagnostics identify operation outside of programmed limits and specific fault information is available even after the unit has been powered down.
- 15. Regulator start-up voltage: Meets ISO8528-3 class G3 specifications.
- Harmonic tolerance: Shall maintain precise control of the generator output with up 16. to 20% harmonic distortion in the generator output voltage.
- 17. Reactive droop adjustment: Adjustable 0-10%.
- Overexcitation protection: Shuts off generator output when excitation current 18. exceeds normal operating currents for 15 seconds or instantaneous shutoff if output is shorted.

#### 2.3 ACCESSORIES

- Α. The engine-generator shall be capable of starting and continuous operation without the use of external power. This excludes the external power for non-operating standby lighting, heat, and ventilation.
- Β. Each engine-generator enclosure shall be provided with protection, distribution, and controls to immediately power accessories and controls.
- C. Power to fans and other accessories shall not be subtracted from the stated generator set rating.

#### 2.4 GENERATOR TERMINAL HOUSING

- Α. Size terminal housing to accommodate all load connections and instrument transformers.
- Generator main leads shall be housed in a terminal housing that allows connections from Β. either the top or bottom, with bottom being used initially. A minimum of 24 inches shall be provided to make stress relief terminations on the main leads. Copper bus shall be suitable for 5kV conductors.
- C. Terminations to generator load terminals shall be done using two-hole, long-barrel, double bolted (NEMA hole spacing) copper compression lugs with cold shrink stress relief terminations.
- Instrument Transformers D.
  - See Appendix A for rating data. 1.
  - Install one set of three current transformers (CT's) and one neutral CT wired in the 2. generator main lead terminal housing. The CTs shall provide differential protection when the generator is connected to the paralleling switchgear. CT's not in use shall be shorted. Provide short-circuiting type terminal blocks and wiring within the terminal housing. Terminals shall be pan-head screw-type for ring terminators.
  - Provide Voltage Transformers (VT's) installed in the terminal housing. 3.
- Surge Protection at switchgear Ε.
  - Provide three phase generator surge protection consisting of surge capacitors and 1. surge arresters mounted in the output terminal enclosure of the generator.
  - 2. Provide generator transient switching analysis indicating minimum cable length from generator terminal to paralleling breaker without requiring surge capacitors at generator terminals.
  - Surge protection shall be suitable for a resistance grounded system and shall be 3. General Electric No. 38F2407, ABB Type 2GUS031803A9, or approved equal.
  - Surge arrestors shall be Intermediate Class Polymer, 5 kV class, MCOV. 4.

## 2.5 DIESEL ENGINE

- A. The diesel engine shall be liquid cooled and shall include engine driven pumps for primary loop coolant circulation. Engine coolant temperature shall be thermostatically controlled to maintain the optimum engine temperature during operation.
- B. Lubrication System: The following items are mounted on engine or skid:
  - 1. Provide a full flow, duplex filtration lubrication system with bypass valve to allow lubrication to continue during high filter restriction. An alarm will be generated when in bypass.
  - 2. Provide an automatic pre-lube oil system to reduce engine wear and improve starting time. It shall run for ten minutes after each engine run period and 15 minutes each hour of standby time.
  - 3. Lubricating oil pump: External engine driven positive-displacement unit having sufficient capacity to ensure adequate lubrication of main bearings, crank pins, camshaft bearings, valve gear, rocker arms and all other wearing parts.
  - 4. Filter and Strainer: Threaded spin-on or canister type full-flow lubricating type, located for easy servicing. Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 5. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and designed to be fail-safe.
  - 6. Crankcase Drain: Arranged for complete gravity drainage with no disassembly and without use of pumps, siphons, special tools, or appliances. Extend past the engine rail with braided stainless hose and reusable fittings to outside the enclosure. Terminate with a ball valve and cap or plug.
  - 7. Crankcase Ventilation Device: Crankcase emission control as required by local environmental permitting authority or if not noted, then provide an air box crankcase ventilation vapor recovery system. Provide a drain valve to expel residue. Provide gauges to measure pressure in assemblies.
  - 8. Pressure sensor: Lubrication oil pressure sensor to pre-alarm on low oil pressure or low oil level. A second sensor shall shut down the engine if the oil pressure falls below a manufacturer-determined safe level.
  - 9. Fill: Provide engine with an initial fill of manufacturer's recommended multiviscosity lubricating oil.
- C. Coolant Jacket Heater: 480V, Electric-immersion type with integral circulating pump, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
  - 1. Provide two (2) engine mounted jacket water heaters sized to maintain coolant temperature of 90 degrees F. with an ambient temperature as noted in Specification 01 81 16 Facility Environmental Requirements.
  - 2. Heater(s) shall be thermostat controlled and set per manufacturer's recommendations. Low coolant temperature set point shall be selected to detect coolant heater failure. The thermostat shall be field adjustable.
  - 3. Provide hand-operated isolation valves to facilitate service without draining cooling system.
  - 4. Heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined temperature level.

#### 2.6 ENGINE COOLING SYSTEM

- Α. The generator set shall be equipped with an integral closed-loop, liquid-cooled radiator factory mounted on engine-generator-set mounting frame and integral engine-driven radiator fan and coolant pumps.
- Β. Cooling Capacity: Capable of cooling the engine based upon the maximum total external air flow restriction on the radiator fan that can be developed by the enclosure when delivering full rated load for altitude and outdoor ambient temperature specified in Specification 01 81 16 Facility Environmental Requirements, but not less than 45°C.
- С Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer. The solution can be reduced to 30/70 if appropriate for the jobsite conditions.
- D. Radiator: Suitable for the specified temperature, acoustical, and system output Performance criteria.
  - Provide site glasses, visible from the generator end of the skid, to monitor coolant 1. level for engine and after cooler.
  - Provide switches to monitor for low coolant level. 2.
  - Adequate to contain expansion of total system coolant from cold start to 100 3. percent of project load conditions as noted above.
  - Provide vacuum/pressure valve filler cap. 4.
- Expansion Tank: Constructed of welded steel plate and rated to withstand maximum E. closed-loop coolant system pressure for engine used. Equip with gage glass and petcock
- F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-. ultraviolet-. and abrasion-resistant fabric.
- Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg G. C), and non-collapsible under vacuum.
- H. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- Ι. Extend coolant drains to outside the enclosure. Terminate with capped ball valve.
- J. Guards: Provide rigid guards for all rotating and moving parts.

#### 2.7 GOVERNOR (ENGINE SPEED CONTROL)

- The engine governor shall be an electronic engine speed control module with a 24-volt Α. DC electric actuator that controls engine speed and transient load response. Engine governor shall work in conjunction with electronically controlled fuel injection system.
- Provide engine governor with the following features: Β.
  - Maintain isochronous frequency regulation from no load to full load. 1.
  - 2. Speed droop shall be adjustable from 0% (isochronous) to 10%, from no load to full rated load.
  - 3. Suitable for proportional load sharing with other units in parallel. Provide load sharing module as required. Coordinate with switchgear and PDCS Suppliers to provide compatible devices and equipment.
  - Provisions for remote speed adjustments. 4.
  - Provisions for field programmability of all engine Performance settings by service 5. technicians

- 6. Speed sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The engine control module shall adjust fuel delivery according to exhaust smoke, altitude, and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.
- 7. Enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination.

# 2.8 COMBUSTION AIR & EXHAUST SYSTEMS

- A. Stainless steel convoluted bellows type flexible couplings shall be furnished to isolate the exhaust piping from engine vibrations. Flexible coupling shall be 24-inch nominal length and capable of accommodating up to 3-inches axial compression and 1-inch lateral displacement between the engine and DPF/SCR.
- B. Provide a fitting shall be provided on the engine manifold to permit back pressure measurements.
- C. Provide sensors to monitor temperature each exhaust manifold.
- D. Provide exhaust pipe and supports on top of the generator enclosure to extend the exhaust pipe horizontally above the enclosure and then discharge vertically upward.
- E. Furnish rain cap for exhaust pipe.
- F. Air-Intake Filter: Dual element, engine-mounted air cleaner with replaceable dry-filter element and blocked filter indicator. At full load operation, the allowable air inlet restriction shall not exceed the recommendations of the engine manufacturer. Provide with a "service required" indicator.

## 2.9 STARTING SYSTEM: 24-V ELECTRIC, WITH NEGATIVE GROUND

- A. Components: Size so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 2.5
  - 1. Cranking Motor:
  - 2. Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Provide redundant electric starting motors such that with the failure of one starter motor, the remaining starters shall be capable of starting the engine within 10 seconds.
- B. Cranking Cycle:
  - 1. Adequate capacity within ambient temperature range specified in Part 25 to provide specified cranking cycle at least three times without recharging.
  - 2. As required by NFPA 110 for Level 1.
- C. Batteries:
  - 1. Provide two independent 24-volt, lead-acid starting battery sets for each engine generator. Each battery set shall be capable of independently starting the generator.
  - 2. Each battery set shall have sufficient capacity to provide a minimum 120-seconds total cranking time without recharging.
  - 3. The batteries shall carry a two-year full replacement guarantee followed by a threeyear prorated warranty. The battery capacity in years three, four and five shall maintain 67%, 33% and 0% respectively, of the published day one rating.

- Batterv Cable: Size as recommended by engine manufacturer for cable length 4. indicated and to take into account voltage-drop associated with the best battery diode system. Include required interconnecting conductors and connection accessories.
- D **Battery Compartment:** 
  - Batteries to be located on each side of the engine. 1.
  - Provide appropriate battery spill containment as required. 2.
  - 3. Battery racks are not required.
  - Boxes shall be factory fabricated of fiberglass or similar industrial guality chemical 4. resistant plastic.
  - 5. Provide thermostatically controlled heater arranged to maintain battery above 5°C (41°F) regardless of external ambient temperature within range specified in Specification 01 81 16 Facility Environmental Requirements. Include accessories required to support and fasten batteries in place.
- Ε. Battery Charger:
  - Provide a fully automatic current-limiting output-filtered battery charger for each 1. set of batteries. Each battery charger shall be dedicated to one starting battery to maintain each battery at full charge and also Provide any normal steady-state 24 VDC load of the engine and paralleling control system.
  - 2. Output
    - 35-ampere rated a.
    - Plus or minus 0.25% voltage regulation b.
    - Battery temperature compensated with adjustable slope C.
    - Filtered to 2% RMS ripple with or without battery attached d.
    - Adjustable current limit 33% to 110% e.
  - 3. Input – [208] [240] volts field selectable – 60 Hz
  - 4 User Interface
    - Backlite, full text LCD a.
    - Charge mode control with LED indicators. b.
    - Battery check system c.
    - LED system mimic panel d.
    - All parameters keypad adjustable with keypad lock e.
  - 5. Alarm System
    - Form C contact for summary alarm a.
    - Individual Form C contact, audible alarm, and visual indication for each of b. the following alarms:
      - 1) AC input fail
      - 2) Low DC voltage
      - 3) Battery end of discharge
      - 4) High DC voltage
      - 5) Charger fail
      - 6) Over-voltage shutdown
      - 7) Ground fault
      - 8) Battery charger summary alarm
    - Wire the following remote monitoring points to the generator control panel: C.

- 1) Battery charger low battery voltage alarm (two per engine)
- 2) Battery charger high battery voltage alarm (two per engine)
- 3) Battery charger summary alarm
- d. Controls and features
  - 1) NEMA PE-5 compliant
  - 2) 2-pole AC circuit breaker
  - 3) 2-pole UL listed DC circuit breaker
  - 4) Electronic soft-start and programmable start delay
  - 5) Alarm and diode protection for reverse polarity connection
  - 6) Fault-tolerant microprocessor controls
  - 7) -40 to 50 degree C. operating range
  - 8) ANSI C62.41 surge withstand
  - 9) Ambient temperature sensor and recording
  - 10) 1% accuracy digital DC ammeters and voltmeters and AC input meters
  - 11) NEMA 1, IP20 steel enclosure with polyester finish
- e. Standards and compliance
  - 1) UL Listed
  - 2) IEC Industrial immunity standards for radiated fields, conducted energy, surge, and ESD.
  - 3) FCC and IEC standards for conducted and radiated emission
- f. Manufacturer: SENS EnerGenius IQ Series or approved equal.
- F. Best Battery Selector
  - 1. Provide a diode based dual battery coupler for each engine. All engine control power and remote-control power to paralleling gear shall be connected to both battery sets through the coupler. Coupler will electrically isolate the two battery sets and their respective battery chargers.
  - 2. Peak current = 4800 amperes, smaller version is allowed if it is rated 150% of max starting current.
  - 3. 30 second rated current at -18 degrees C.= 7150 amperes
  - 4. 30 second rated current at 50 degrees C. = 4950 amperes
  - 5. Engine-start duty cycle = 90 seconds continuous duty minimum
  - 6. SENS-BBS-4800 or approved equal
- G. Battery Charging Alternator
  - 1. Provide an engine driven battery charging alternator connected to one of the starting batteries only. The alternator shall not be connected to both batteries and shall not utilize a diode splitter.
- 2.10 ENGINE FUEL SYSTEM
  - A. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

- Β. Fuel Pre-Filters: Heavy duty, high-capacity fuel pre-filter/water separators equips with water separator alarm. Filters shall be 30 micron with a maximum clean pressure drop of 1.7 psi at 540 GPH. Provide Kraissl (3-way valve) and differential pressure gage with alarm switch. Wire alarm contacts to the generator control panel for local and remote annunciation.
- C. Fuel Cooler: Provide a factory-mounted air-cooled fuel oil cooler mounted within the radiator air stream to cool the return fuel. Size cooler sufficient to remove enough excess heat from the return fuel line to prevent temperature rise in fuel tank.
- Flow Meter: Provide an in-line fuel flow meter with an integral bypass. D.
- E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- Hand Fuel Pump: Gorman Rupp Model H03, or a factory mounted fuel priming pump F. that is designed to apply a vacuum to pull fuel up from the engine mounted fuel transfer pump.
- G. Solenoid Valve: The fuel line shall NOT have an electrical solenoid valve. Provide option to eliminate this item. All associated wiring diagrams to be updated to show this item deleted if elimination is accepted.
- Fire Safety Shut-off Valve: Provide a fusible link operated lever gate valve in the Provide Η. fuel line inside the generator enclosure. The fusible link shall be UL listed.
- Provide 120V, 10GPM positive displacement fuel return pump for returning fuel to main Ι. tank should main tank fuel pump(s) malfunction and continue supplying fuel when should be off. Connect to circuit breaker in generator 120/240V panelboard. Include hardwired monitoring point to generator controller for "FUEL RETURN PUMP ACTIVATED"
- 2 11 BASE MOUNTED FUEL OIL TANK
  - Α. Factory installed and piped, complying with NFPA 30, UL142 and local fire codes steel double-contained protected fuel oil tank.
  - Β. Fuel tank shall be designed with a V shaped floor above the structural support of the tank with 2% slope to the center of the tank. The baffles in the fuel tank shall be designed to create a continuous fuel flow without any dead spots to prevent growth and moisture accumulation in the fuel.
  - Containment: Provide integral rupture basin with leak detector connected to Engine C. Controller to provide local and remote audio and visual alarms at the PDCS gear.
  - Fuel Level Monitoring: D.
    - Mechanical Fuel Level Gauge: Manual tank level indicator on 2" port to be provided 1. adjacent to the fill port. Liquid level indicator: Krueger Therma Gauge-Type H.
    - Electronic Fuel Monitoring Panel: 24VDC electronic fuel monitoring panel with 2. digital display for reading alarm conditions and gallons of fuel in tank. Provide product interface card to allow monitoring of status, alarms, and fuel level (gallons) by a third-party monitoring system over an RS-485 serial connection using open Modbus RTU protocol. Panel to be NEMA-4 rated.
  - Fuel Level Alarms: Provide the following fuel tank level sensors and contacts: Provide E. five (5) sets of contacts for each alarm. Contacts shall be DPDT rated 5 amperes - 120 VAC and 24 VDC.
    - 1. Alarm and fuel start/stop contacts shall be delivered from separate level sensors.

- 2. Critical high-level alarm contacts to remote fill panel 95% capacity (105% of useable fuel)
- 3. High level alarm contacts to remote fill panel 90% capacity (This shall be annunciated as 100% usable fuel)
- 4. Critical high-level alarm contacts to engine controller 95% capacity (105% of useable fuel)
- 5. High level alarm contacts to engine controller 90% capacity (This shall be annunciated as 100% usable fuel)
- 6. Remote Pump #1 Run contacts 85% capacity (Remote Pump On contacts) (75% of useable fuel)
- 7. Low level warning contacts to engine controller 80% capacity (70% of useable fuel)
- 8. Remote Pump #2 Run contacts 80% capacity (Remote Pump On contacts) (70% of useable fuel)
- 9. Low level alarm contacts to engine controller 35% capacity (25% of useable fuel)
- 10. Critical low level alarm contacts to engine controller 20% capacity (10% of useable fuel)
- 11. Fuel tank containment (leak) alarm contacts to engine controller.
- 12. Wire one set of contacts (all sensors) to the generator controller and another set to the local fuel alarm annunciator. Wire one set of contacts (leak only) to the electronic fuel monitoring panel.
- 13. Provide protective steel barriers for fuel tank sensors and wiring.
- F. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and sump with capped pipe accessible on the side of generator enclosure to allow fuel to be pumped out. All piping to have socket welded connections.
  - 1. Two (2) 2" spare NPT couplings in tank.
  - 2. Two (2) 4" spare NPT couplings in tank.
  - 3. 2" Engine Supply: Provide dip tube with Double Poppet Foot valve.
  - 4. 2" Engine Return: Provide dip tube.
  - 5. 2" Fuel Return port with dip tube for the return fuel pump with Double Poppet Foot valve.
  - 6. Pump out port for containment tank.
  - 7. 2" threaded port for the remote fuel fill from main tank. Extend piping to outside of enclosure on the right side. Refer to drawings.
  - 8. 2" threaded port for pressure relief.
- G. Fuel Tank Vents: Provide a primary and an emergency vent for the fuel tank and the secondary containment. Extend all vents above the enclosure roof or 12 feet above grade if mounted outside of enclosure. Provide insect caps on end of piping by installing contractor.
- H. Fuel Fill Containment: Provide 7.5-gallon fuel spill and overflow containment mounted outside enclosure at local refill location. Provide lockable fuel refill cap. Manufacturer to comply with all federal and local fuel fill and/or fuel spoil containment requirements.
- I. Emergency Backup Fill port: Fill port shall be accessible inside the engine turning vane enclosure with visibility of fuel level gauge. Normal skid tank filling will be from the remote main fuel tank. Provide Fuel Shutoff Valve for skid tank overfill protection that positively shuts off the fuel flow at 90% high fuel stop alarm.
- J. Tank Pressure Test: Primary and secondary tanks shall be pressure tested in accordance with NFPA 30, 31 and all national and local codes. The tank shall be retested on site after delivery.
- K. Signage/Labeling: "Diesel Fuel, Flammable, No Smoking" & NFPA Label.

#### 2.12 WIRING

A. Engine and generator internal control wiring shall be multi-strand, plastic-insulated cable that is resistant to heat, abrasion, oil, water, antifreeze and diesel fuel. Each cable shall be heat-stamped to identify the cable's origin and termination. Cables shall be enclosed in nylon flexible conduit, slotted to allow moisture to escape and facilitate easy access.

#### 2.13 ENGINE GENERATOR CONTROL AND MONITORING SYSTEMS

- A. Each generator shall have a local Engine-Generator (EG) control panel uniquely designated to the engine-generator it serves including all operating and safety indications, protective devices, basic system controls, and engine gages. Mounting method shall isolate the control panel from generator-set vibration. All required interfaces to Medium Voltage Switchgear and PDCS shall be provided to facilitate all control, monitoring and protection functions. The information portion shall be via Ethernet using Modbus TCP/IP protocol, the control portion must be hardwired.
- B. Each control panel shall provide the following metering, status and alarm functions.
  - 1. Analog displays and gauges:
    - a. Volts (average)
    - b. Amps (average)
    - c. Power factor meter
    - d. Kilowatts
    - e. Frequency
    - f. DC voltmeter (alternator battery charging).
    - g. Engine-coolant temperature gage.
    - h. Engine lubricating-oil pressure gage.
    - i. Running-time meter
  - 2. Red indicators for shutdown or failure alarms:
    - a. Low lube Oil pressure
    - b. High engine water temperature
    - c. Overcrank
    - d. Overspeed
    - e. Critical low fuel
    - f. Under frequency; shutdown after cooldown
    - g. Overcurrent; shutdown after cooldown.
    - h. Reverse power; shutdown after cooldown.
    - i. Loss of excitation; shutdown after cooldown.
    - j. Undervoltage; shutdown after cooldown.
    - k. Reverse phase rotation
  - 3. Amber indicators for alarm only conditions:
    - a. Pre low lube oil pressure
    - b. Pre High water temperature
    - c. Low water temperature
    - d. Low coolant level
    - e. Low fuel Skid tank
    - f. Critical Low fuel Skid tank

- g. Critical High fuel Skid tank
- h. Skid tank Leak
- i. Control voltage failure
- j. Low DC battery voltage
- k. High DC battery voltage
- I. Battery charger failure
- m. Ground fault via SEL-700G relay in the GS switchgear and neutral grounding resistor.
- n. Under frequency
- o. Engine locked out (Shutdown due to failure)
- p. Generator overload.
- q. Generator not-in -auto
- 4. Green indicators for status indication only:
  - a. Engine running
  - b. Generator in Auto
- C. Each control panel shall have the following operating controls for initiating starting, stopping and paralleling of the EG:
  - 1. 3-position ECS: Off-Auto-Manual (Run)
  - 2. Emergency-Stop (red latching) for immediate shut down and lock out of the EG. Each switch shall require manual reset and be capable of accepting a lockout tag and safety lock.
  - 3. Generator-voltage adjusting rheostat.
  - 4. Reset switch to clear all faults present in the Engine generator to allow re-start after a system shutdown.
  - 5. Lamp test button
  - 6. Alarm silence button
- D. Each control panel shall include an automatic engine controller with the following features:
  - 1. Engine start time delay, 0-300s.
  - 2. Engine cool down, 0-600s.
  - 3. Automatic synchronizer and load control to control the output voltage, frequency, and phase angle of the generator during paralleling. Located in PDCS switchgear.
  - 4. Isochronous load sharing control unit: The load sharing control unit shall be compatible with the engine governor system to work in conjunction with governor and other paralleled generator to equally share the total KW load among all paralleled EG's to within 5%. The unit shall be provided by the EG manufacturer for mounting in the Control panel.
  - 5. Generator voltage regulator: The EGCP shall contain a voltage regular matched with the engine governor system. The voltage regulator shall be provided by the EG manufacturer for mounting
  - 6. Isochronous kVAR load sharing: the VAR sharing unit shall provide equal sharing of the total reactive load among the paralleled generators to within 5%.
  - 7. Automatic engine control packages for starting, stopping, and monitoring the engine, with the following features:
    - a. Engine cranking: 3 attempts of 15 seconds, with a rest period of 15 seconds.
    - b. Over crank lockout after (3) unsuccessful Cranking attempts.
    - c. Switch to allow continuous cranking.
    - d. Communication interface capable of receiving all EG alarms and status indicators and transmit to local display and EPMS.
  - 8. Fail to synchronize relay adjustable time delay 10 to 120 seconds.

- 9. Phase rotation relay.
- E. Each control panel shall include an engine governor control unit compatible with the supplied engine and appropriate for electronically controlled injection type engines.
- F. Utility-Generator Intertie Breaker and Paralleling Controllers
  - Provide all required interfaces and programming to be able to be controlled by the 1 Woodward LS-5, or approved equal integrated breaker controller, in the PDCS paralleling gear to provide the automatic synchronizing, closed transition loading and unloading.
  - 2. Provide all required interfaces and programming to be able to be controlled by the Woodward Easygen 3500XT or approved equal paralleling operation controller, in the PDCS paralleling gear to provide coordinated operation of multiple generators part of the system.
  - Provide all required interfaces and programming to be able to comply with utility 3. company requirements for duration and 100mS overlap.
- G. Automatic Starting System Sequence of Operation: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch on PDCS gear, also shuts down generator set.
- Local Manual Starting Sequence of Operation: When the mode-selector switch is in Η. Local, the generator-set shall be able to start and parallel to a dead bus or to other generators in a local manual mode.
- Ι. Instrument Transformers:
  - Current and Potential Transformers: Metering accuracy class. MV CT's shall be 1. C200 rated.
  - 2. All current transformers shall match those provided by medium voltage switchgear Supplier.
- Supporting Items: Include sensors, transducers, terminals, relays, and other devices and J. include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- K. Network Interfaces
  - 1. Provide an Ethernet based Network to facilitate a network interface between the Generator Supplier and the PDCS System for local and remote annunciation.
  - 2. Each intelligent device provided by the Supplier shall have RJ45 Ethernet port for connection to the Network. All enclosures with intelligent devices shall be connected by conduits, suitable for CAT6 cabling including spare capacity for at least (1) additional CAT6 cable, to the point where the underground communication conduit will stub up.
  - The allowed network protocols are Modbus TCP/IP and IEC 61850. 3.
  - Supplier is responsible for ensuring all devices are setup properly and 4. communicating reliably with the paralleling control and monitoring system.
- Coordinate with PDCS suppliers for device selection, including options and interface L. modules.

- 1. PDCS Coordination Meeting: Generator Supplier shall participate in a 4-hour coordination meeting at the project site to coordinate all set points, device settings, time delays and other relevant programming with the GC, Engineer, Electrical Contractor, PDCS Suppliers, and other equipment suppliers. The purpose is to develop a fully coordinated electrical control and monitoring system for the Owner. Final settings shall be documented in the O&M manuals supplied under this Division.
- 2. All alarms and measurements specified herein shall be made available for remote access via the Ethernet port using Modbus TCP/IP protocol. Provide all necessary programming and gateways. Connect to 24VDC starting battery system. Provide protocol converter only where Ethernet ports are not available from the manufacturer on the respective controller. Provide one Ethernet connection per device controller. Use of multiple daisy-chained serial connections per protocol converter is not allowed. Generator main controller shall be latest model with integral Ethernet port, protocol converters are not allowed for this device.
- 3. Generator enclosure shall contain two (2) combination smoke/heat detectors. The detectors shall connect to a fire alarm panel inside the building via an addressable network. The fire alarm panel shall be interconnected to the associated Generator Master Control PLC. Upon activation of both detectors in an enclosure, the generator shall be disconnected from the paralleling bus and shutdown. The locations and installation of the heat and smoke sensors must be coordinated with the heat sources in the enclosure like the engine turbo charges and high-volume airflow to confirm that they will operate correctly and prevent false alarms.

# 2.14 GENERATOR PROTECTION

- A. Neutral Grounding
  - 1. Provide each generator with resistance grounded neutral system, utilizing an enclosed stainless-steel resistor mounted in the generator enclosure. The resistor shall be provided with a protective enclosure, insulators, etc. as required.
  - 2. Provide 100A, 10-second rated neutral CT for connection to the MV switchgear. Coordinate with the Switchgear supplier on CT ratings. Wire to shorting blocks and terminals.
  - 3. A 100:5, 5 kV, T200 accuracy class CT shall be installed on the neutral terminal side of the generator and the CT secondary wired back to the control relay in the generator paralleling switchgear for alarming.
  - 4. Lead from generator neutral to resistor rack shall be full voltage rated (5 kV) cable, minimum #1/0 AWG Cu, MV-105.
  - 5. Locate NGR and associated CT in a location that is accessible by ladder for periodic maintenance.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device shall send a signal to the medium voltage switchgear to disconnect/trip the generator from load circuits. Protector shall Provide the following:
  - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

- 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
- 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Medium Voltage Switchgear Generator Protective Relay: Generator Protective Device will be furnished and installed in the medium voltage paralleling switchgear associated with the generator, by the supplier of the medium voltage paralleling switchgear. The Supplier shall provide the required instrument transformers and interfaces and coordinate connection points, wiring requirements, control voltages and currents and settings with switchgear supplier. The following functions will be provided:

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Non-directional Overcurrent (Instantaneous and Time)	50/51	3 >, 3 >>, 3 >>>	PIOC PTOC	Secondary winding
Non-directional Earth/Ground Fault	50N/51N	I <sub>0</sub> >, I <sub>0</sub> >>, I <sub>0</sub> >>>	PIOC PTOC	Neutral
Non-directional Earth/Ground Fault	50N/51N	I <sub>0</sub> >, I <sub>0</sub> >>, I <sub>0</sub> >>>	PIOC PTOC	Ground
Voltage Restrained Overcurrent	51V	U71>	PVOC	
Negative sequence or phase-balance current	46	l <sub>2</sub> >	PPBR	
AC directional ground overcurrent	67G	I <sub>0</sub> →>	PTOC	
Undervoltage	27	3U<	PTUV	No lockout
Overvoltage	59	3U>	PTOV	No lockout
Phase-sequence or phase-balance voltage	47	U <sub>2</sub> >	PPBV	No lockout
Volts per Hertz (Overexcitation)	24	V/Hz>	PVPH	
Synchronism Check	25G		RSYN	Generator Sync-check
Directional (reverse) Power	32R	P←> or -P>	PDOP	Motoring protection
Under frequency	81U	f<	PTUF	
Over frequency	810	f>	PTOF	
Frequency rate of change	81R		PFRC	
Generator Differential	87G	3dl>G	PGDF	

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
Loss of Field	40	Χ<	PDIS	
Breaker Failure	50BF	3I>/lo>BF	RBRF	
Circuit Breaker Trip Circuit		TCS	SCBR	For both trip coils for each
Supervision				breaker. Alarm only
Protective Relay Failure				Fail-safe design that on internal relay failure or loss of control power trips the associated breaker(s)
Lockout	86G		PTRC XCBR	Breaker Reclosure Lockout for the associated Generator Circuit Breaker
Breaker Wear Monitoring				

D. Generator Local Protection. Coordinate with Generator Suppliers to obtain trip signals for the following physical and backup protection functions:

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
Description	Function	Function	Function	
High Engine Oil	26Q	T>	PTTR	
Temperature				
High Coolant	26Q	T>	PTTR	
Temperature				
Stator Thermal	49S	T>	PTTR	
Overload				
Non-directional	50/51	3 >, 3 >>,	PIOC	
Overcurrent		3 >>>	PTOC	
(Instantaneous				
and Time)				
Negative	46	<sub>2</sub> >	PPBR	
sequence or				
phase-balance				
current				
Undervoltage	27	3U<	PTUV	No lockout
Overvoltage	59	3U>	PTOV	No lockout
Phase-sequence	47	U <sub>2</sub> >	PPBV	
or phase-balance				
voltage				
Under frequency	81U	f<	PTUF	
Over frequency	810	f>	PTOF	

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Function Description	ANSI/IEEE Function	IEC 60617 Function	IEC 61850 Function	REMARKS
Directional (reverse) Power	32R	P←> or -P>	PDOP	
Reverse Reactive Power (kVAr)	32RV	Q←> or -Q>	PDQR	

E. Local Protection Functions: The Supplier shall provide a local protection relay with the following functions implemented as a minimum:

F.

Function	ANSI/IEEE	IEC 60617	IEC 61850	REMARKS
High Engine Oil Temperature	26Q	T>	PTTR	
High Coolant Temperature	26Q	T>	PTTR	
Stator Thermal Overload	49S	T>	PTTR	
Non-directional Overcurrent (Instantaneous and Time)	50/51	3l>, 3l>>, 3l>>>	PIOC PTOC	
Negative sequence or phase-balance current	46	l <sub>2</sub> >	PPBR	
Undervoltage	27	3U<	PTUV	No lockout
Overvoltage	59	3U>	PTOV	No lockout
Phase-sequence or phase-balance voltage	47	U <sub>2</sub> >	PPBV	
Under frequency	81U	f<	PTUF	
Over frequency	810	f>	PTOF	
Directional (reverse) Power	32R	P←> or -P>	PDOP	
Reverse Reactive Power (kVAr)	32RV	Q←> or -Q>	PDQR	

1. SAFETY Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

### 2.15 GROUNDING

- A. Weld two NEMA Standard copper grounding pads at opposite corners of the Genset skid/fuel tank. Extend ground wires from both ground pads to generator frame.
- B. Provide a ground pad 18" to the left of the rear doors, in order to allow bonding the generator platform. The grounding pad shall accommodate a NEMA two-hole, long barrel compression lug.

#### 2.16 **VIBRATION ISOLATION**

- Α. The Engine-Generator and radiator shall be mounted to the base with suitable springtype vibration isolators.
- The Restrained Spring Isolators shall be freestanding steel, open-spring isolators: Β.
  - Operating efficiency better than 95 percent 1
  - 2. Built-in resilient vertical limit stops.
  - Tapped holes in top plate for bolting to equipment. 3.
  - Neoprene pad attached to baseplate underside. 4
  - Outside Spring Diameter: Not less than 0.8 of the compressed height of the spring 5. at rated load.
  - Minimum Additional Travel: 50 percent of required deflection at rated load. 6.
  - Lateral Stiffness: More than 80 percent of the rated vertical stiffness. 7.
  - Overload Capacity: Support 200 percent of rated load, fully compressed, without 8. deformation or failure.
  - 9. Vibration isolator selection, quantity, locations, and size, type, and number of attachment bolts shall be determined by the vibration isolator manufacturer and as per approved submittals.
  - 10. Meet the seismic requirements for the site. Use importance factor of 1.5.
- C. Manufacturers: Aber-Booth, Cal-Dyn, Mason Industries, Vibration Eliminator Co., Vibration Mounting & Controls, Inc., or Vibrex Vibration Control Systems.
- UL CLASSIFIED WEATHERPROOF SOUND ATTENUATED GENERATOR NON-2.17 WALK-IN ENCLOSURE
  - Provide seismic-rated support structure for Emissions Control Equipment as a part of the Α. enclosure.
  - Β. Doors
    - 1. All doors on the enclosure shall be strategically located in areas as to allow ease of maintenance on the generator set and allow good access to and visibility of instruments, controls, engine gauges, etc.
    - 2. Doors shall be provided with a perimeter gasket and a bolt-on piano-type hinge constructed with brass or aluminum hinge pins of a diameter not less than .25". Each door shall be provided with a key lock handle, three-point latch and an interior door opener. Lock cylinder type shall be coordinated with the owner.
    - 3. Equip all doors with drip rails for water runoff.
    - Equip all doors with emergency egress hardware as required by code. 4.
    - All doors shall be capable of being opened 180 degrees, with provisions to allow 5. the doors to be secured in the fully open position.
  - C. Rain Skirt
    - At the point where the exhaust pipe flexible tubing penetrates the roof of the 1. enclosure, a suitable "rain skirt" and collar shall be provided by the manufacturer. It shall be designed to prevent the entrance of rain and allow expansion and vibration of the exhaust piping without chafing or stress to the exhaust system. This detail must appear on the shop drawings.
  - D. Sound Attenuation
    - The entire enclosure except for the louvered openings shall have sound 1. attenuation material mechanically attached to the interior surfaces of the unit. The sound absorption material shall be held in place by a perforated galvanized metal

sheeting to form a removable section easily inspected by maintenance personnel. The sound attenuation material and fastening system shall apply to the enclosure roof as well as the side panels and doors.

- 2. The enclosure package including the silencer and exhaust system shall be designed to achieve a sound rating specified in Paragraph 2.1 at any point when measured at a distance of 23 feet at any point around the perimeter free field while operating at full rated load.
- E. Base and Mounting
  - 1. The engine-generator set, enclosure, and fuel tank shall be prefabricated, tested and shipped to the jobsite on a common structural steel sub-base with provisions for crane unloading of the complete package, if possible, or shipped as multiple separate components.
  - 2. The base shall accommodate lifting and skidding of the unit as a whole during shipping, rigging and installation. The base shall be designed and built to resist deflection, maintain alignment, minimize resonant linear vibration.
  - 3. The non-walk-in enclosure shall be the Drop-Over type and shall be shipped separately.
  - 4. The entire unit weight consisting of generator set, base, enclosure, fuel tank and all other specified items including all liquids (i.e., fuel oil, lube and cooling water) shall be calculated by the manufacturer. The base of the unit shall be engineered, designed, and manufactured as a heavy duty, welded steel construction with four (4) point lifting provisions as used on heavy duty construction installations. Details and manufacturer's certification of the base construction shall be included with the shop drawings.
  - 5. The non-walk-in enclosure footprint shall match the footprint of the in-base fuel and Urea tank.
- F. Enclosure flooring
  - 1. The floor of the enclosure shall be raised, solid steel, diamond plate, non-skid deck floor plate painted ANSI 61 and shall be capable of supporting any ancillary equipment specified which may be secured to it (such as batteries, etc.) plus the anticipated weight of maintenance personnel and their tools. There shall be no exposed beams in the enclosure interior area.
  - 2. Under no circumstances shall the floor area or any of its parts be considered for cooling air intake or discharge requirements of the generator set or its associated equipment, nor shall its properties as a "heat sink" or heat dissipating medium be utilized in any manner whatsoever in this application.
- G. Oil and Coolant Drains
  - 1. The Provide all necessary fittings, hoses, shut-off valves, etc. required to facilitate lube oil and water drain at the exterior of the enclosure. In addition, engines equipped with crankcase breather tubes shall have this tube terminate at the exterior of the enclosure.
  - 2. Properly label all drain locations on exterior of the enclosure.
- H. Engine Cooling Airflow through Enclosure
  - Construct enclosure for rear air intake with full rain hood on one end and top air discharge on the other end. If side air intakes are required for additional inlet louver area, the intakes cannot extend past footprint of the enclosure (i.e. no rain hoods) since the generator ventilation system must be capable of working with a maximum aisle of 5 feet spacing between adjacent engine generators.

- 2. Maintain temperature rise of system components within required limits when generator set operates at 100 percent of rated load and maximum specified ambient temperature in Project Conditions above.
- Louvers: Fixed-engine, cooling air inlet and discharge. Storm-proof and drainable 3. louvers prevent entry of rain and snow and shall have sufficient free area to allow for 120% of the total engine-generator cooling air requirements used in this application. Provide bird screen at louvers and all air intakes and discharge points.
- Automatic Dampers: At engine cooling air inlet and discharge. Dampers shall be 4. closed to reduce enclosure heat loss in cold weather when generator set is not operating.
  - Inlet Dampers: Motorized closed and spring open type (fail-safe operation). a.
  - b. Discharge Dampers: Gravity type or motorized closed/ spring-open if less static pressure drop is required.
  - Provide low leakage inlet and discharge dampers with edge seals having a C. Class 1A rating per AMCA 500.
- Provide hinged and lockable access hatch to the exhaust discharge area from 5. outside the enclosure for maintenance and clean-out. Do not provide hatch without hinges.
- 6. Provide stainless steel drip pans below the air intake sound attenuators and within the exhaust airway, pitched to a minimum of two (2) 2-inch drain openings to the exterior of the enclosure. Provide removable heavy gauge steel mesh rodent quards at each drain location.
- 1 Interior Lighting
  - 1 Provide six (6) 4-foot LED lamp luminaires within the enclosure and strategically located on either side of the generator set to provide adequate illumination for inspection and maintenance. They shall be wall mounted and parallel to the length of the unit.
  - 2. Interior and exterior lighting shall be fed from 120VAC panelboard provided with generator.
  - Provide four (4) 24 VDC light fixtures with adjustable light heads illuminating the 3. area of the generator controller. DC light fixtures shall be powered from the best battery source selector, be separately fused, and wired through a rotary timer switch with automatic shutoff, with 6-hour, no hold time cycle. Locate at the four interior corners of the enclosure.
  - Provide two three-way switches for controlling interior fixtures located adjacent to 4. two of the entrance doors of the structure on opposite sides. Each light switch box shall have its own GFI protected duplex mounted receptacle mounted therein for use by maintenance personnel.
- **Exterior Lighting** J.
  - Provide a minimum of four (4) exterior, flush mounted J-boxes wired and ready for 1 installation of LED lighting fixtures (by site electrician) and wired to a common photocell (provided herein) on the enclosure. Locate two (2) J-boxes on each side of the enclosure above the principal access doors.
  - The Supplier shall provide a waterproofed exterior junction box for the shipped-2. loose exterior LED lighting to be provided and re-installed by the site General Contractor.
- Κ. **Convenience Outlets** 
  - 1. Minimum of two (2) factory-wired, 120-volt GFCI duplex receptacles with gasketed hinged covers on the interior of the enclosure (one on each side of the enclosure)

- L. Panelboards and Transformers Outlets
  - Provide one Square D, NF type, or equivalent, 480 volt, 3-phase, 3-wire, NEMA-1 3R distribution panelboard rated for 35 kAIC with 125A 3-pole main circuit breaker for external incoming service to the generator enclosure and servicing 480 volt loads within the enclosure. Conduits for the field installed Incoming feeder shall be sized to accommodate 150A feeder.
  - 2. Provide Square D Mini Power Zone, or equivalent: one 480-208/120-volt, kVA size as required to accommodate all loads plus 25% spare, 1-phase, 3-wire dry type distribution transformer in NEMA-3R enclosure, wall mounted with vibration isolators. If Mini-Power Zone is not possible then provide standard 3-phase, drytype transformer with SQD NQOD panelboard or equivalent. Install high enough on wall so to allow personnel to walk underneath integral with one 208/120 volt. 1phase, 3-wire, 42-pole, NEMA-3R branch circuit panelboard with 60A 3-pole main circuit breaker for serving 120 VAC and 208 VAC power within the enclosure.
  - If 1-phase Mini-Power-Zone is used then each generator supplied shall be 3. connected to different phases to allow load balancing of 480V distribution system serving the gensets. Example Gen-1 use Phase A&B; Gen-2 use Phase B&C, Gen-3 use Phases C&A
- M. Enclosure and Power Wiring
  - All electrical wiring installed per the National Electrical Code and all applicable 1. local codes. All control, signaling, and power wiring (600 volts and less) within the enclosure shall be installed in EMT conduit with steel-compression fittings or liquidtight flexible.
  - 2. All power and control conductors shall be copper.
  - All medium voltage power cables shall be Type MV105, copper, EPR, 5 kV, 133% 3. insulation, 5 mil overlapping tape shield, PVC jacket.
  - 4. Label all wires within the generator enclosure to match the power and control wiring drawings. Mount laminated power, control power and piping drawings on the interior wall of the generator enclosure. Include a generator plan and elevation identifying all of the component locations within the generator enclosure.
  - 5. The complete enclosure including panelboards, transformers, neutral ground resistor, lighting, receptacles, lighting controls, environmental equipment, controls, battery system, and fuel system shall be pre-wired. Service to the enclosure will be 480 volts, 3 phase, 3-wire, 125 amperes.
  - 6. The neutral grounding resistor shall be mounted inside the enclosure, if possible and remains accessible. (Neutral Grounding Resistor mounted outside enclosure on the roof is not desired, but allowed if required to be inside).
  - 7. Provide for entrance of medium voltage power conductors (power conductors will be routed underground from generator enclosure to building at air intake end of enclosure. Coordinate exact location with installing contactor. Provide all required conduit or wireways between stub-up entrance location and generator output terminals.
  - 8. Provide for entrance of 480-volt power conductors, power conductors will be routed underground from generator enclosure to building at air intake end of enclosure. Coordinate exact location with installing contactor. Provide all required conduit or wireways between entrance location and 480-volt panelboard.
  - 9. Provide for entrance of low voltage auxiliary system conduits for systems such as controls, fire alarm and communications, auxiliary conduits will be routed underground from generator enclosure to building at air intake end of enclosure.

Coordinate exact location with installing contactor. Provide all required conduit and wireway between entrance location and termination points within the enclosure.

- 10. Wire the following status and alarm contacts to the generator control panel for remote monitoring via the PDCS system:
  - a. All specified Starting Battery Charger monitoring points
  - b. All specified Fuel level/ leak monitoring points
  - c. Return fuel pump monitoring points.
- N. Heating
  - 1. The enclosure shall be heated and ventilated to keep the ambient interior air temperature not less than 50 degrees F minimum in the low outdoor ambient temperature noted above and a maximum of the high outdoor ambient temperature noted above or as required by manufacturer of electrical components. These temperature requirements are when the generator is not running. Heat may rely on the engine jacket heaters or additional space heaters shall be provided at the manufacturer's option.
  - 2. If unit heaters are required then provide at 480V, 3 Phase, 3-wire, interlocked to be automatically turned off when genset is running.
  - 3. Interlock heating with engine generator so heaters are inoperative during engine generator operation.
  - 4. Provide individual adjustable thermostats mounted in the enclosure for heating systems.
- O. General
  - 1. Maximum enclosure dimensions including fuel tank: Refer to drawings.
  - 2. The generator enclosure shall be of formed steel or aluminum construction. The design and construction shall be modular in that the side panels and doors shall not exceed 36 in width and shall be a minimum thickness of 12-gauge for all component parts. Enclosure walls and ceiling shall be provided with 3" minimum thick fiberglass or mineral wool thermal and acoustic insulation with 22 gauge galvanized perforated interior liner.
  - 3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
  - 4. The roof of the enclosure shall meet or exceed the minimum gauge requirements specified but, in addition, shall be strengthened in such a manner as to support the exhaust silencer recommended by the engine manufacturer for this application plus code required design for snow loading. The roof of the enclosure shall be pitched to allow for natural draining of rainwater. Subject roof assembly to a water leak test after completion.
  - 5. All components of the enclosure shall be assembled utilizing .375" minimum zincplated bolts, nuts, and lock washers. In addition, watertight neoprene flat washers shall be used on all roof bolts.
  - 6. Provide galvanized mounting brackets for the exhaust silencer specified. In addition, a 90-degree exhaust elbow with a rain cap to prevent the entrance of rainwater shall also be supplied. Further, a stainless steel, seamless, flexible exhaust tube and all necessary bolts, flanges, and gaskets to mate with the engine and exhaust silencer shall be provided. The length of the flexible tubing shall be such that additional solid metal nipples or sections shall not be required to be provided as spacers between the engine exhaust or the exhaust silencer.
  - 7. The enclosure shall be designed to contain any liquid leak including fuel oil, coolant, lubrication oil, battery electrolyte within the enclosure and not to escape into the environment.

- 8. Enclosure and anchorage shall be designed to meet the sustained wind rating specified in Specification 01 81 16 Facility Environmental Requirements.
- 9. Radiator discharge shall be thru the top of the enclosure.
- P. Platforms, Railings and Stairs
  - 1. Pre-manufactured galvanized steel platform with handrail/ steps to be provided by this generator enclosure supplier. Refer to civil and architectural drawings for sizes and stair layout. Each set of stair risers to be designed to work with the slope of the generator yard.
  - 2. Provide #2AWG bonding connection from generator enclosure to the platform/ step assembly. Use two-holt bolted connection lugs.

### 2.18 IDENTIFCATION, NAMEPLATES AND PLATE DIAGRAMS

- A. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of items.
- B. Engraved laminated plastic nameplates, having black letters on white background, or as noted otherwise, shall identify major components, vertical sections, and circuit breakers. Nameplates shall be attached with self-tapping screws. Refer to details in the construction drawings.
- C. Rigging Diagram: Shall be inscribed on a metal plate permanently attached to the engine skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.
- 2.19 FINISHES
  - A. Indoor and Outdoor Enclosures and Components:
    - 1. Provide Upon final assembly of the enclosure, it shall be prime painted with a minimum of two (2) coats of rust-inhibiting primer with manufacturer's standard polyurethane finish over corrosion-resistant pretreatment and compatible primer.
    - 2. Color to be factory standard Tan color for enclosure with black for diesel and Urea tanks.

### 2.20 CATALYTIC REDUCTION SYSTEMS FOR ENGINE EXHAUST

- A. Acceptable Integrated DPF, DOC, and SCR System Manufacturers: Miratech/ Rypos.
  - 1. Cummins emissions system cannot be used due to the large 480V (>600KW per generator) power connections required.
- B. The engine shall be furnished with a catalytic reduction system to reduce engine exhaust emissions to US EPA Tier 4 Final compliance levels. The system shall meet the limits required for the power rating of the engine, at 100% load. However, the system shall be capable at providing and reducing emissions at any load above 25%.
- C. The reducing agent metering and control system shall be capable of ensuring that the maximum ammonia slip to atmosphere from the SCR system shall not exceed 10 PPMV
   @ 15% O2 while the system is in steady state operation.
- D. SYSTEM COMPONENTS
  - 1. General
    - a. The installation of the exhaust after treatment system shall include all material and parts required for the system.
  - 2. Housing

- a. Shall be designed to contain and support a complete DPF/SCR integrated catalyst reactor housing with racks/tracks for DPF, SCR, and DOC catalyst material to meet PM, NOx, CO, and VOC Performance specifications. The housing shall be a rigid structure, which will not warp or deform significantly during normal operation.
- b. The Housing shall be complete with inlet and outlet transition sections designed for bolting to the exhaust gas ductwork. The reactor shall be provided with mounting brackets for attachment to a support structure. Lifting lugs shall be provided as recommended by the Manufacturer to properly lift and set the housing in place. Lifting lugs shall be designed to allow lifting a fully loaded housing.
- c. Shall be equipped with access doors to the catalyst. The doors shall be easily re- moved without the assistance of lifting equipment and be on top or the side of the housing and shall provide access to each layer of catalyst without removal of any adjacent catalyst.
- d. Shall be provided with internal catalyst support structure and perforated plates or other flow dispersion method.
- e. Shall provide instrumentation ports for differential pressure and temperature at the inlet and outlet flanges. Additional instrumentation ports shall straddle the DPF, DOC, and SCR catalyst beds.
- f. The Urea Mixing Section should be fully integrated within the housing and should be of adequate length to achieve proper mixing and hydrolysis.
- g. SCR housing shall be insulated using 3 inches minimum, mineral wool batts with textured corrugated aluminum lagging (flat lagging shall not be allowed). Joints shall be sealed with a high temperature caulk to prevent water intrusion. Insulation shall be "boxed" and flashed around all sample ports. Access doors shall have removable 2-inch-thick blankets consisting of mineral wool blanket with stainless steel mesh on the hot side, UV stabilized silicone impregnated fabric on cold side. All mineral wool batts and blankets shall have minimum 1000 deg F temperature rating.
- h. Software required for servicing of the SCR control panel and PLC shall be installed on the owners Windows Server v2016.
- E. Active Diesel Particulate Filter (DPF) Blocks
  - 1. The filter media shall be extruded, porous mullite material blocks with square mono- lithic channels (honeycomb structure). Each channel shall be plugged on one end only, with adjacent channels plugged on opposite ends, such that flow must pass through the walls between adjacent channels.
  - 2. The blocks shall have a square cross section, so that they can be stacked easily. They shall be approximately 150 mm x 150 mm in cross section and 300 mm in depth.
  - 3. The blocks shall be coated with a catalyst material to lower the exhaust temperature required for regeneration to 525°F/274°C.
  - 4. Particulate regeneration shall not be dependent on NOx:PM or NO:NO2 ratios in the exhaust.
  - 5. Provide supports and mounting hardware of all control power transformers for the DPF system. Including circuit breakers and power wiring from panelboard to the transformer and to the DPF connection points. Clearly label all circuits in the panelboard schedule.
- F. Diesel Oxidation Catalyst Elements (DOC)

- 1. DOC element shall consist of a metal substrate consisting of alternating corrugated layers of metal foil that is layered and stacked in an off-set, overlapping, pattern and electronically resistant welded. The channels shall provide a high surface area and multiple turbulent zones without causing excessive exhaust backpressure. Substrate shall be enclosed in a 304SS shell with integrated handle.
- The catalytically active materials shall be a precious metal coating on the DOC 2. that is made from a combination of platinum and palladium. The catalyst substrate and metal foil shall not sinter or degrade when exposed to exhaust inlet temperatures up to 1,250°F (677°C).
- A single high temperature fiberglass gasket shall be wrapped around the element 3. to seal it within the housing. The top surface of the sealing plate shall be sealed against the door when it is installed.
- The DOC element(s) must be removable via bolt-on access doors. This will allow 4. for the element(s) to be sent to the supplier/manufacturer for periodic washes and allows easier replacement of damaged/poisoned catalyst(s). The completed elements shall weigh less than 80 pounds (36 kg), so they can be installed without the need of over- head lifting equipment.
- G. SCR Catalysts
  - Shall be an extruded ceramic honeycomb designed for low pressure drop and high 1. sur-face area. Active catalyst material shall be uniformly mixed into the ceramic as part of the extrusion. Coated catalysts are not acceptable.
  - Shall have an operating range of 572°F to 977°F 2.
  - Shall be provided as individually gasketed blocks which are stacked in the catalyst 3 housing. No single SCR catalyst block or element requiring handling shall be greater than 15 lb.
- Η. Urea Injection lance
  - 1. The urea injection lance shall be constructed of 304 Stainless Steel. It shall be installed via a flanged port on the Catalyst housing. Lance shall be a 2-phase type using com- pressed air to atomize the urea solution as well as to purge and cool the lance.
  - 2. Injection lance shall be easily removed for maintenance and shall only require standard hand tools.
- Ι. **Urea Mixing Section** 
  - The mixing section shall be fully integrated within Catalyst housing. 1.
  - Mixing section shall have the number and type of mixers, flow straighteners, etc., 2. as determined by the Manufacturer to provide adequate urea hydrolysis and thorough mixing with the exhaust.
- SCR Control System: Analysis Controlled Injection System (ACIS-2) J.
  - The reducing agent metering and control system or closed loop monitoring system 1. shall be programmable Logic Controller based and provide automatic SCR system start-up, operation, shutdown, monitoring, and annunciation of abnormal conditions.
  - 2. The reducing agent to be used in the SCR system shall be technical grade urea dissolved in demineralized water to provide a 32 to 40 percent aqueous solution.
- K. SCR Control System
  - The SCR shall be provided with an Open Loop Control System 1.
  - SCR Closed Loop Control Unit (Optional) 2.

- Analysis of the NOx concentration shall be via a redundant integrated a. electrochemical cell-based sample system. Interfacing with 3rd party analysis systems shall not be al- lowed.
- b. Control system shall use an analog (4-20 mA DC) engine load signal (supplied from the Gen-Set Controls) to set the base urea injection rate. Manufacturer's Technicians shall develop the injection map during commissioning.
- Urea injection shall be "trimmed" based on the feedback from the NO C. analyzer (closed loop control). In the event of emission measuring system malfunction, the control shall revert to open loop and alarm the operator.
- 3. Data shall be available to the operator via an integrated touch panel. Remote monitoring and control shall be available via Ethernet connection to the controller.
- All operating parameters shall be available via Modbus TCP for connection to 4. Owners electrical power management system.
- The system shall automatically stop and re-start under the following conditions: 5.
  - SCR Catalyst bed temperature less than 570 °F a.
  - Engine shutdown b.
- Control Unit enclosure shall be NEMA 1 rated for indoor installation. Provide 6. Control Unit with an integral Air Conditioner to allow for operation up to 120° F ambient temperature.
- L. **Urea Metering Panel** 
  - The Dosing Control panel shall include the urea and compressed air handling 1. components including pressure switch, metering valve, flow meter, etc.
  - 2. Dosing Control shall be directly controlled by the Closed Loop Control Unit to adjust the urea flow rate as required. Flow meter shall provide feedback to the Control Unit that the appropriate flow is achieved, and be used for consumption monitoring. Dosing Control shall contain air pressure manifold with low pressure switch tied back to the Control Unit.
  - 3. Since ambient temperatures will be 35° F, provide Dosing Control panel with heater(s) and insulation to prevent freezing/crystallizing of the urea.
  - Dosing Control panel shall be suitable for outdoor installation with NEMA 4 or 4. equivalent rating.
- Urea Booster Pump M.
  - Provide skid mounted urea pump, inside generator enclosure, with required 1. pressure regulator, relief valve, pulsation dampener, etc., as specified by the manufacturer. Pump shall be controlled by the SCR Control Unit. Provide one pump per system.
  - Pump skid shall be suitable for outdoor installation in ambient temperatures down 2. to 35° F. Since the installation has an ambient temperature below 35° F, provide a pump enclosure with heater(s) and thermostat to maintain temperature above freezing. Pre- plumb all urea Provide and return lines to bulkhead fittings on the enclosure.
- N. Air Compressor
  - Provide skid mounted air compressor, inside the generator enclosure to Provide 1. injection/purge air as required for proper operation. Air compressor shall be oil-free rotary vane type and shall not re- quire lubricators.
  - Compressor skid shall be suitable for indoor installation in ambient temperatures 2. up to 145° F.
- О. Urea Storage Tank and Accessories

- 1. Urea storage tank shall be custom designed, with inspection manway, double wall stainless steel tank suitable for storage of liquids up to 1.9 specific gravity, integrated with the pump and controls skid.
- 2. Tank shall have fittings for urea supply to pumps, urea return from pumps, level sensor, and urea fill. The urea fill shall have a drop tube to the bottom of the tank.
- 3. Urea tank shall be insulated with minimum 3" of foam insulation with mastic cover. Urea tank shall be provided with a heater and heat traced and insulated to maintain urea at 40° F in low ambient conditions noted herein, if required. Heat trace shall operate on 120VAC single phase. Heat trace temperature control panel shall be NEMA 4 and shall be embedded in the insulation. Control shall have a high temperature shut-off. Heat trace control panel shall have alarm contact wired to SCR control panel PLC for communication to operator.
- 4. Urea tank temperature shall be monitored and alarmed thru either the SCR controller.
- 5. Urea tank shall be of sufficient capacity for 72-hours of SCR operation at 100% engine load using a Urea tank built into the skid area.
- P. Urea fill port
  - 1. The fill port shall be accessible from outside the engine enclosure with mechanical urea level gauge.
- Q. Provide a level indicator and low-level alarm system. Level sensor shall be ultrasonic type with analog output back to a level indicator reading out in gallons. (2) sets of alarm contacts for low level shall be provided (one set for the Closed Loop Control this should be capable of reporting to the PDCS PLC.
- R. Sound Attenuation
  - 1. The overall sound attenuation levels of the generator enclosure system plus the DPF/SCR system shall not exceed the levels specified above.
- S. Installation
  - 1. The DPF system shall be supported by the enclosure. The support structure shall be coordinated with door, and other access openings.
  - 2. All components shall be located inside the enclosure immediately behind access doors. Equipment may be stacked as long as access to all other equipment I snot impaired. Coordinate with generator supplier for access space issues.
  - 3. Both the 480 V and 208Y/120 V genset power panels/ transformer shall be upsized to accommodate all DPF loads. Provide submittal showing a summary of loads included for serving the generator and serving the DPF system.
  - 4. Any equipment that requires exterior mounting shall be provided with permanent seismically and wind-braced metal shading to minimize solar gain impact on the assembly.
  - 5. The entire emissions system, noted above, shall be fully installed by the enclosure manufacturer, in their factory. This includes all mounting hardware/ supports, all tubing, power and control/ monitoring wiring between all components. System shall be designed to be able to be disassembled for shipment with only the absolutely required joints and splices. Provide instructions and pictures/ videos of how the system and the various assembles are to be reassembled at the jobsite.
- 2.21 SOURCE QUALITY CONTROL
  - A. Factory test all engine generator sets at the enclosure manufacturer's factory prior to shipment to the site.

- B. Factory test the fully assembled generator set, enclosure, and base fuel tank at enclosure manufacturer's factory to demonstrate conformance with this specification. Testing may possibly be witnessed by the Customer and shall include all previous engine generator factory tests including 4 hour heat run.
- C. Factory Test Basis
  - 1. Include testing of equipment manufactured and fully assembled, specifically for this project.
  - 2. Include DPF/SCR radiators, and all accessories required for operation of the diesel generator.
  - 3. Provide all resistive load banks and power cables to achieve full rated load at unity power factor for the duration of the tests.
  - 4. Use instruments calibrated within the previous twelve months and with accuracy directly traceable to the National Institute of Standards and Technology.
  - 5. The scheduled factory tests MAY be witnessed by representatives of the Owner, the Architect/Engineer and the Electrical Contractor. Provide fourteen days advance notice of the witnessed factory tests. Do not include cost allowances for FWT, as this may not be required.
  - 6. The Supplier shall submit to the Architect/Engineer for approval a detailed procedure of the proposed tests three weeks prior to the scheduled factory tests.
  - 7. All equipment shall be ready for operation prior to start of the witnessed tests.
  - 8. If equipment does not pass successfully and a second factory visit is required, Supplier shall pay travel expenses for Owner and Engineer to make additional factory visit(s).
- D. Factory Tests
  - 1. The factory tests shall be provided to demonstrate the capability of the diesel engine-generators to accept and continuously carry rated full resistive and reactive load at rated voltage, frequency and unity power factor. Operation of all safety and monitoring devices shall also be demonstrated and documented. The Owner reserves the right to witness the rest of the engine-generators.
  - 2. Each diesel generator shall be given the transient tests described herein to demonstrate that the response of the diesel generator to load application meets the specified limits of voltage, frequency excursions and recovery time. A high-speed disturbance analyzer with a waveform analyzer and strip chart recorder shall be used to record sub-cycle voltage and frequency transients. A hard copy of the results shall be forwarded to the Architect/Engineer.
  - 3. Step load tests shall be resistive load only as follows: 0% to 50%, 50% to 0%, 0% to 75%, 75% to 0%, 25% to 100%, 100% to 25%, 0% to 100%, and 100% to 0%.
  - 4. Pure capacitive load test verify maximum capacitive load until generator goes on shutdown/over-excited mode.
  - 5. Each diesel generator shall then be operated at full rated load for four (4) hours using a factory load bank. During the full load tests, readings shall be recorded of the values listed below. The readings shall be made at 30-minute intervals, starting at the beginning of the test and including the values at the end of the cool-down period.
    - a. Ambient temperature, barometric pressure and humidity.
    - b. Generator three phase kilowatt load.
    - c. Generator three phase kVA load.
    - d. Generator currents in all three phases.
    - e. Generator voltage across all three phases.
    - f. Generator frequency.

- g. Engine coolant temperature.
- h. Engine lube oil pressure.
- i. Engine lube oil temperature.
- j. Engine fuel consumption.
- k. Exhaust gas temperature/each cylinder.
- I. Bearing temperatures from each RTD.
- m. Stator windings temperatures from each RTD.
- 6. Measure harmonic content of output voltage under 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- 7. Generator rotor winding and stator winding temperature prior to the test and at the completion of the test shall be determined by the resistance method and recorded. Demonstrate that all digital communications data points are functional.
- 8. Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches of water. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
- 9. Water infiltration Test: While the generator is running, spray directional water at all louvers, openings and roof to verify minimal water infiltration
- 10. Air Restriction Test: While the generator is running, obtain differential pressure measurements to determine the total pressure drop from outside enclosure, through intake louvers, across radiator, and through exhaust louvers or turning vane. Provide calibrated manometer and all necessary tubing and sensing apparatus to Provide test. Outdoor enclosure will be completed for the factory acceptance test. Outdoor enclosure will be inspected by the Owner and Engineer for conformance with the contract documents. Provide temporary 480V power to generator enclosure to allow all generator support systems to be operational.
- 11. Sound Test: Record the sound pressure levels at the rated distance in all four directions under the following conditions:
  - a. Generator startup
  - b. Generator operating at no-load
  - c. Generator operating at full load
- 12. Make vibration measurements at five locations.
- 13. If the equipment fails to meet Specification requirements during the witnessed factory tests, the Supplier shall correct the cause of the failure and repeat the tests to the satisfaction of the Owner prior to shipment.
- 14. Six legible certified copies of the test results shall be provided to the Architect/Engineer. The test results shall include a log of all readings taken during the test run.
- 15. The Witness Testing Report shall be submitted to the Architect/Engineer in hard copy and soft copy.
- E. Enclosure Vendor Virtual Inspection
  - 1. Prior to when assembly is complete and prior to disassembly for shipping, the Enclosure Vendor shall:
    - a. Set up a Virtual Inspection tour meeting of the finished generator package. Notify the Contractor, Owner and Engineer (The Team) a minimum of 5 days before the Virtual meeting. These 5 days are not meant to be added to the schedule duration length but to just allow for adequate Team schedule notification of the meeting date.

- b. Submit one or more preliminary video file(s) to the Team two days prior to the Virtual Inspection, showing the entire enclosure, including closeups of all components, to allow for comments prior to the Virtual inspection below.
- c. Provide all live camera feeds and Zoom type meeting application to allow for this live Virtual Inspection for the Team to see the enclosure and offer any final comments/ instructions prior to shipping. Plan for a minimum of 2-hours.

# PART 3 - EXECUTION

#### 3.1 EXAMINATION AND PREPARATION

- A. The Contractor shall verify dimensions, tolerances and method of attachment with other work.
- B. The Contractor shall verify that openings, conduit stub-ups and overhead works align with the equipment to be installed in place.
- C. The Contractor shall verify that anchoring devices have been properly installed and located.
- D. Installation work can only proceed if the installation location is examined and prepared to receive the equipment. Notify Owner and its representatives, if area preparation does not conform to the installation requirements and tolerances.

### 3.2 CLEANING AND PROTECTION

- A. After receipt of equipment and prior to acceptance, the Contractor shall keep the installed products clean and shall provide adequate equipment protection throughout the project.
- B. At no time shall personnel be allowed to sit or stand on equipment or use them as support for working above. Internal components, electronics, coils and windings, shall be kept clear of dust, filings and other construction debris.
- C. Enclosures moisture protection. Ensure that all doors and covers are properly closed and tightened after field installation and field terminations. Ensure that there are no openings to the environment and if needed provide temporary covers/protection. Connect permanent or temporary power to enclosures with heaters to manage moisture content. If power cannot be provided for an extended period of time place and maintain desiccants in enclosures with sensitive equipment.
- D. Cleaning: Inspect interior and exterior of installed equipment. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish. Periodic cleaning shall be performed where required. The equipment shall be given a thorough cleaning prior energization and prior to turn-over.
- E. Any damage to the equipment prior to turn-over shall be corrected to original condition and to the Owner's satisfaction at the Contractor's cost.

## 3.3 INSTALLATION

- A. The Contractor shall provide labor for the installation of all Generator plus all associated external materials for power connections, extension of control power circuits, interconnects to PDCS gear, and all control and monitoring wiring.
- B. Reassembly of Items Disassembled for Shipping: The contractor shall provide labor for the reassembly of the following items:

- 1. Where the generator system requires disassembly at the Enclosure Vendor and shipping via separate shipments, such as, Generator, Fuel Tank, Emissions system, Enclosure and various fittings, the Contractor shall provide labor for all the various trades required to complete the reassembly of those items.
- 2. All cranes and rigging required for unloading and installation shall be responsibility of the Contractor.
- 3. The Supplier in conjunction with the Enclosure Vendor shall provide advanced notification of the number, size, weight and estimated shipping dates of each required shipment. Provide the is information as far in advance as possible.
- C. The Supplier shall provide all termination lugs and cable termination kits required to make up cable terminations. Power wiring lugs shall be two-hole NEMA drilled long barrel double compression type matching the terminal bus configuration, landed with Belleville washers and hardware with grades as detailed on the Drawings, and torqued per the Manufacturer's specifications or, if Manufacturer's specifications are not available, per drawing details. The Supplier shall verify the cable size and quantity with the Engineer prior shipment.
- D. All internal power connections shall be of two-hole, long-barrel, double-crimp compression type lug terminations with viewing window to see end of the conductor.
- E. The equipment shall be installed following the procedures set forth by the Supplier. The Supplier shall assist the Contractor as required in interpreting the installation instructions. The Contractor shall certify to the Supplier and the Engineer that the installation has been provided per the Supplier's latest documents and instructions.
- F. The Contractor shall provide concrete equipment pads where shown on the Drawings. The pads shall extend between 12 and 24 inches beyond the dimensions of the equipment base structure, with additional extension where auxiliary transformers are located. The pads shall incorporate leveling steel channels that are suitable for welding to switchgear bottom channels for anchoring purposes.
- G. The Contractor shall solidly anchor all equipment to the equipment pads. Embedded anchor bolts or bottom rail welding shall be provided by the Contractor and approved by the Manufacturer. No anchoring devices shall be installed outside the overall dimensions of the equipment.
- H. Generator should be thoroughly cleaned after installation and testing is completed.

### 3.4 FIELD QUALITY CONTROL

- A. Factory-Authorized Service Representative: Provide the services of a qualified factoryauthorized service representative to supervise reassembly, installation, equipment startup, commissioning, and site acceptance testing. Provide technician(s) for the total time required to complete the above work. Total time spent on-site may not be continuous.
- B. Supervised Adjusting, Pretesting and Startup: The factory-authorized service representative shall supervise all system functions, operations, and protective features for conformance with Specifications. Startup shall include all time required to achieve proper operation of each piece of equipment provided.
- C. Alignment: After installation is completed, check all related components to ensure alignments are within recommended tolerances. Provide vibration measurements to confirm components are operating within manufacturer accepted tolerances.

- D. Commissioning: Equipment Supplier shall provide factory authorized service representative on-site support during equipment commissioning. A minimum of 10-man days per generator shall be included in the bid. Support shall be dedicated and to this project until successful commissioning completion.
- E. Provide certification in writing that the installation of the diesel engine generator sets are in compliance with the manufacturer's written installation instructions and published Performance criteria.
- F. On-Site Tests and Inspections: The factory authorized representative shall supervise and provide instrumentation, cables, and equipment for the following tests. All testing shall be witnessed by the Owner's Commissioning Agent. The Commissioning Agent has the right to modify and/or include additional testing other than what is listed below, and the Contractor and factory authorized representative shall include an allowance for all labor and equipment for such testing in their bid. The Contractor shall provide threephase power analyzers to record testing results and submit results in writing. The Contractor and factory authorized representative shall include in their bid labor support and load banks/test equipment to Provide these tests during both Level 3 and Level 4 phases of commissioning in accordance with the Owner's Commissioning Agent requirements.
  - 1. Provide tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. NFPA 110 Acceptance Tests: Provide tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Provide an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  - 4. Alarm tests: Verify all alarms locally and remotely, including facility EPMS system.
  - 5. Crank test: Conduct a cycle crank test on each engine generator to prove compliance with specifications.
- G. Site Acceptance Testing Individual Generator Units: The factory authorized service representative shall supervise and provide instrumentation for the following tests:
  - 1. Integrated System Testing: The Supplier shall provide on-site support for the duration of equipment integrated system testing. A minimum of two-man days shall be included in the Bid. Support shall be dedicated to this project and assigned to work continuously until successful integrated system testing completion.
  - 2. Heat run test: Eight hours at full resistive and reactive load using load bank provided by the Contractor. Heat run tests shall be Provided over afternoon hours to approximate design conditions to the extent possible with enclosure doors closed at all times and actual operating conditions. Simulate loss of utility power to automatically start generators. Record the total time from start parallel operation of all generators. Fail redundant generator and observe proper operation of

remaining generators. Run generators in parallel at full design load continuously for four hours, record the following every 15 minutes:

- a. Voltage and Frequency
- b. Load Sharing
- c. Coolant temperature
- d. Visual observation for leaks, vibrations, alarms and other anomalies.
- 3. Step load transient response test: Step load tests shall be resistive load only as follows: 0% to 50%, 50% to 0%, 0% to 75%, 75% to 0%, 25% to 100%, 100% to 25%, 0% to 100%, and 100% to 0%.
- 4. Noise Level Test: Measure A-weighted level of noise emanating from generatorset installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- H. Provide a high-speed disturbance analyzer with a waveform analyzer and strip chart recorder shall be used to record sub-cycle voltage and frequency transients. Verify proper operation of the following:
  - 1. Cooldown cycle
  - 2. Inlet and exhaust louver operation.
- I. Battery-Charger Tests: Verify specified rates of charge for both equalizing and floatcharging conditions.
- J. System Integrity Tests: Verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and liquid leaks.
- K. Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches of water. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the diesel engine.
- L. Exhaust Emissions Test: Comply with applicable government test criteria. Provide and document with and without SCR system operation.
- M. Voltage and Frequency Transient Stability Test: Use three-phase recording power analyzer (Dranetz 440 or equal) to measure voltage and frequency transients for 50 and 100 percent step –load increase and decreases, and verify that Performance is an specified.
- N. Harmonic-Content Test: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- O. Fuel for testing: Contractor shall provide fuel for testing and top off all fuel storage and day tanks to full level upon completion of function testing and integrated systems testing.
- P. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- Q. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each test component indicating satisfactory completion of tests.
- R. Following completion of the site tests, inspect all filters, take oil and coolant samples and Provide laboratory evaluation to determine presence of unwanted metals and liquids and

quality of fluids. Submit report to Owner. Replace all filters and lubrication oils after the tests.

# 3.5 MANUFACTURER'S FIELD SERVICE

- A. The Manufacturer shall demonstrate the ability to maintain a local competent service organization. This field service organization shall:
  - 1. Be located within a reasonable distance of the project with a normal response time not to exceed 24 hours between receipt of a request for service and arrival of service personnel at the Owner's site.
  - 2. Be fully capable of providing high-quality, factory-trained service personnel and Manufacturer-certified replacement parts.
  - 3. Able to provide service on 24 hour seven days a week basis.
  - 4. Establish and maintain procedures for:
    - a. Qualification/certification of field service technicians.
    - b. Escalation of field service problems to Manufacturer's engineering support when required to back up field service technicians.
    - c. Document and software/firmware version control.
    - d. Spare parts inventory control.
  - 5. Customer notification of Manufacturer's equipment upgrades and product service alert bulletins.
  - 6. Replacement parts shall be of the same manufacture as provided by the original Supplier.
  - 7. The name, address and twenty-four-hour telephone number of the nearest authorized service organization shall be displayed on the inside of the door of each enclosure.
  - 8. The Supplier or Supplier's representative shall attend a schedule coordination meeting at the site prior to start of construction for the purpose of integrating installation schedule of other Suppliers and the Contractor.
  - 9. The Supplier shall provide the services of a field service engineer as required for installation supervision and complete site testing. Field service work for installation and testing may require weekend or overtime hours. Allowance must be stated within the bid for field service work that may occur outside of normal working hours. Premium charges for such work outside of normal hours must also be stated within the bid. If not stated prior to bid acceptance it shall be assumed there is no restriction to or premium cost for weekend and overtime work.
  - 10. In the event that testing and commissioning activities determine repair or correction of the Switchgear and/or Switchgear components is required, field service must be supplied and unlimited, and must continue until satisfactory system operation and Engineer's approval has been achieved.

# 3.6 SITE ACCEPTANCE TESTS

- A. The Engine-Generator Supplier, with the assistance of the GS paralleling Switchboard Supplier, shall be responsible for the Performance of all site tests on the Engine-Generators as required to certify the proper operation of the Engine-Generator power system as a whole.
- B. Upon completion of the site work and adjustment of all equipment, the Engine-Generator Supplier, with the assistance of the Switchboard Supplier, shall conduct an operating test as scheduled with the contractor. All systems and equipment shall be demonstrated

to operate in accordance with all requirements of the Contract documents and to be free from all electrical and mechanical defects.

- C. The Contractor, Engineer, Commissioning Agent and Owner are expected to witness manual and automatic functions of the Engine-Generators as well as other site tests, in conjunction with the EG Control Switchgear and Main Switchgear, shall be demonstrated to the Owner.
- D. The Supplier's field service technicians shall provide all special instrumentation required to Provide the tests.
- E. The Supplier shall coordinate with the Contractor schedules for all phasing of the site tests.
- F. The Engine-Generator Supplier shall furnish factory-trained engineers for a minimum of six (6) working days, or longer as needed to Provide all site acceptance tests to the satisfaction of the Owner.

#### 3.7 TEST WITNESS AND INSPECTIONS

- A. The Purchaser/Owner reserves the right to inspect the equipment at the equipment manufacturing facility for conformance with this specification prior to shipment. The Seller shall notify the Purchaser and Owner in writing at least 10 working days prior to shipment to permit the Purchaser or the Owner the option of inspecting the equipment at the factory.
- B. Release by the Owner to ship, or waiver of the inspection in no way shall relieve the Manufacturer or Supplier of responsibility for the equipment being in conformance with this Specification and applicable standards.
- C. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this Specification are subject to rejection by the Owner. The Purchaser/Owner reserves the right of rejection at the job site if the above conditions are discovered even after acceptance at the factory.
- D. Prior notification of all site tests shall be required. The Owner's representative shall witness site tests. Scheduling of site tests shall be coordinated with the Engineer prior to startup. All retests due to improper notice or test failure shall be conducted, as required, at the Seller's expense.

### 3.8 TEST REPORTS

- A. The Manufacturer, Supplier and independent testing agencies shall supply their certified test reports and data for each of the factory and site tests conducted by them as specified herein.
- B. All test data shall be recorded and certified by the Manufacturer or testing agency conducting the aforementioned tests. Any defects noted during the tests shall be brought to the attention of the Engineer for corrective action. Submit all test reports for approval and/or corrective action via the project document management platform.
- C. Each test report set submitted shall be clearly identified by the Purchaser's name, the project name, the purchase order numbers, the equipment description and specific identification, and the manufacturer's name and address.

## 3.9 DEMONSTRATION & TRAINING

- A. The bid shall include the cost for the services of a factory authorized service representative to train the Owner's On-Site Work Force (OSWF) on procedures and schedules for programming, setting of relays, startup, shutdown, troubleshooting, servicing and preventive maintenance of all equipment. The instruction shall include:
- B. The instruction shall be dedicated, intensive and shall be provided by competent instructors fully familiar with the equipment.
- C. The instructions shall be presented in one eight-hour session.
- D. The Owner will provide a suitable classroom environment on site for the instruction sessions.
- E. The cost of the 10 hours of training on the generators, broken up into two days, including hands-on and classroom instruction sessions shall be included in the Base Bid.
- F. Provide soft copies of the instruction manuals and presentations.
- G. Schedule training with the Owner with at least seven working days advance notice and provide advance copies of training program to Owner.
- H. Provide both classroom training and hands-on equipment operation covering the following:
  - 1. Safety precautions.
  - 2. Features and construction of diesel engine generators and accessories.
  - 3. Routine inspection, test and maintenance procedures.
  - 4. Routine cleaning.
  - 5. Features, operation, and maintenance of protective devices.
  - 6. Interpretation of readings of indicating and alarm devices.
  - 7. Review operating and maintenance manuals.
  - 8. Review troubleshooting operations.

### END OF SECTION

### APPENDICES FOLLOW BELOW

Description	Unit	Ratings	Remarks
I. Service Conditions			
Location, altitude, wind speed,	-	See Specification 01 81 16	
seismic, air pollution and other		Facility Environmental Data	
location specific requirements.		(separate document for each	
		site)	
Installation Location		Outdoors	
Governing Standards		USA, ANSI/IEEE	
II. Main Data			
ISO 8528 Performance Rating		Limited Time Prime (LTP)	Up to 500 hr/year @ 100%
		Power	prime power rating
			-15% to +20% Voltage
ISO 8528-5 Transient Response		Class G3	-7 to 10% Frequency
			4msec response time
Noise	dBA	75	23 feet from enclosure
Utility Paralleling		Yes, closed transition with 100	
		mS overlap	
Number of Generators in		3, only (1) initial installation	
Parallel			
Generator Capacity Rating	KW	2000 KW	Usable capacity, after
			deducting parasitic loads
			and derating for site
			environmental conditions
			(elevation, temperature,
			etc.). Values based on
			previous projects, propose
			most optimal for the site.
Basis of Design for Generator	Model	Cummins OSK60-G6 NR2	CAT. Kohler allowed
	No.		bidders
Operating Frequency	Hz	60	
Operating Voltage	КV	4.160V	
Output Configuration	-	3PH. 4W with NGR	
NGR Rating	Α	100	10 sec Rating, calculate
			impedance as required
			of Operating Voltage
Voltage Adjustment	%	+/- 10%	
Power Factor Range	-	0.8 Lag to 0.9 Lead	
Steady State Voltage Stability	%	+/-0.5	
	0/		
	%	+/-0.25	
	0/	04.0	
Generator Efficiency	%	94.8	@ Full Load

# APPENDIX A: ENGINE GENERATOR SET RATINGS AND PERFORMANCE REQUIREMENTS

Description	Unit	Ratings	Remarks
Maximum Number of		2	
Paralleled Generators		5	
Maximum X"d	%	15	
Starting Time	sec	6	To fully rated voltage and frequency accepting full- rated load in one step (not including synchronization to a parallel bus)
Sustained Short Circuit Current	%	300 of rated full-load current for 10 seconds minimum	3-phase, bolted short circuit at system output terminals
Fuel		Fuel oil grade DF2	
Skid Fuel Tank Capacity @ rated load	Hours	6	Oversize the tank to account for 5% bottom dead space and 10% freeboard.
Remote Main Fuel Tank Capacity (not part of this spec)	Hours	72	UL2085 tank with duplex fuel pumps serving this generator.
Power to Package	VAC	480Y/277, 3-phase. 4-wire	Coordinate circuit capacity with Engineer
III. Emission Controls			
Emissions		Tier IV Final Compliant Levels - guaranteed 0.04 g/bhp-hr or better	@ 25%, 50%, 75% and 100% Loads
Diesel Particulate Filter (DPF)		3-stage with 480V heaters	Miratech Rypos AT4
Emission Controls		Selective Catalytic Reduction (SCR)	Miratech
Urea (DEF) Tank Capacity @ rated load	Hours	72	
DEF temperature management		Provide heat tracing for cold climates and shading/insulation of tank to minimize temperature impact on life of DEF.	Delete heat tracing and associated accessories if not required for the jobsite location.
Exhaust Stack Diameter	Inches	24"	
Exhaust Stack Outlet Height	Feet	25'	Discharges vertically with rain cap
Exhaust Stack Gas Flowrate	CFM	15,385 @ 900F max.	
IV. Current Transformers			
Purpose		Differential and ground fault Protection to switchgear protective relaying	
Location		Terminal housing	

Description	Unit	Ratings	Remarks
Quantity		(3) phase CTs plus (1) neutral	Must match type, size, mfgr to the ones in the PDCS
Data		Coordinate with Switchgear	
		Manufacturer	
V. Voltage Transformers			
Purpose		GCP metering and voltage regulation	
Location		Terminal housing, line-side connected	
Туре		3-phase, wye-wye	Group 4B
Protection		Fused primary and secondary	
Accuracy		0.3 W, X, M, Y, 1.2 Z @ 69.3 V	ANSI
Load		1,500 VA @ 30°C ambient;	
		1,000 VA @ 55°C ambient	
BIL		60kV	

END OF APPENDICES

## SECTION 26 33 23

#### STATIONARY BATTERY SYSTEMS

#### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Scope of Work This Section includes the requirements for the following redundant Station Battery Systems and Equipment:
  - 1. Design and selection of the station battery system and components to meet the requirements specified herein.
  - 2. Battery sizing calculations
  - 3. Batteries as required with spare jars as specified
  - 4. Inter-cell and inter-tier cables, bus bars, and hardware as required
  - 5. Battery racks
  - 6. Battery chargers with remote monitoring.
  - 7. Thermal Runaway Detection/ Shutdown system and remote monitoring.
  - 8. Ethernet Monitoring interface to the Generator paralleling switchgear PLC
  - 9. DC disconnects and DC distribution panelboards
  - 10. Spill containment

#### 1.2 REFERENCES

- A. Comply with the Standards, Codes and Guides referenced in this specification section. Applicable documents include, but are not limited to, the latest version of all standards, codes and as well as all applicable sections and referenced standards within. Where conflicting information is presented, study is to comply with the most stringent of the conflicting standard, code, and/or guide.
- B. Compliance with the following Standards, Codes and Guides
  - 1. Global Compliance
    - a. American National Standards Institute (ANSI)
    - b. Environmental Protection Agency (EPA)
    - c. National Electrical Code (NEC)
    - d. Underwriters' Laboratories, Inc. (UL)
    - e. Institute of Electrical and Electronics Engineers (IEEE)
      - 1) IEEE 1106 Installation, Maintenance, Testing and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications
      - 2) IEEE 1115 Recommended practice for Sizing Lead-Acid Batteries for Stationary Applications
      - 3) IEEE 1660 Application and Management of Stationary Batteries Used in Cycling Service
    - f. National Electrical Manufacturers' Association (NEMA)
    - g. International Electrical Testing Association (NETA)
    - h. NFPA 70E Standard for electrical safety in the workplace
    - i. International Building Code (IBC)

C. Drawings: Wherever the terms "Plans" or "Drawings" are used in these specifications, they shall refer to the Issued for Construction Drawings for this project. These Drawings together with this specification and other specifications make up the Procurement and/or Construction Documents for this project. The equipment proposed to be furnished under these specifications shall be compatible with the space provisions and wiring configurations as shown on these Drawings.

### 1.3 DEFINITIONS

- A. The following terms appearing in this specification shall have the following meanings:
  - 1. ATS: Acceptance Testing Specifications.
  - 2. NETA: International Electrical Testing Association.
  - 3. "Engineer" or "EOR" refers to the professional engineer in charge of performing the study and documenting recommendations, licensed in the state where project is located.
  - 4. "Switchgear Manufacturer" refers to the manufacturer of the Switchgear the station batteries will be connected to.

# 1.4 SYSTEM DESCRIPTION, DESIGN AND PERFORMANCE REQUIREMENTS

- A. Station Batteries and the associated components specified herein shall be integrated into a single package from a single manufacturer with responsibility for entire equipment installation and performance.
- B. The MV Generator Paralleling Switchgear (MVGPS) vendor shall be responsible for design and provision of this station battery system.
- C. General Performance Requirements
  - 1. The Station Battery design shall provide safe and reliable operation.
  - 2. The Station Battery systems shall be designed, selected and compatible with the associated switchgear it will be providing DC power to:
    - a. 15KV Main Service Switchgear: MVMS2
    - b. 5KV Main/ Generator Paralleling Switchgear: MVMGPS2
    - c. 5KV Distribution Switchgear: MVDSA & MVDSB
  - 3. The Station Battery best source selector in the paralleling switchgear shall be provided to transfer the load from one source to another or if the source supplying power to the load falls out of tolerance.
  - 4. Bonding: The Station Battery support structure shall be solidly bonded to the building ground system.
- D. Seismic-Restraint Design: Station Battery assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces. Additional local requirements shall be as specified in Specification 01 81 16 Facility Environmental Requirements and in accordance with Section 26 05 48 Vibration and Seismic Controls for Electrical Equipment, where 26 05 48 provided.
- E. Naming Convention. The Owner will provide a naming convention for the supplied equipment. Drawings, documents and equipment identification shall utilize the Owner's naming convention.
- F. Maintainability

- 1. All designs shall be undertaken to ensure that maintenance requirements are minimized and shall consider full life cycle costs including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified herein.
- G. Concurrent Maintainability. The Station Battery package shall be designed to be isolated and individually taken out of service for maintenance and repairs and returned to service without impacting the rest of the system as long as the backup AC/DC power supply is functioning, including upstream equipment and downstream equipment.
  - 1. The Supplier shall incorporate the following maintainability design concepts:
    - a. Materials shall be selected to provide corrosion- and wear-resistance protection that is adequate for the environment and service. Should a material not be replaceable with a corrosion resistant one, the susceptibility shall be mitigated with coatings as appropriate for the environment as described in this specification.
  - 2. The equipment shall be able to be moved via a pallet in order to minimize the need to utilize excessive manpower or cranes for maintenance. In the event the equipment is too large or heavy to be transported via a pallet, manufacturer shall include lifting lugs for handling bulky, heavy, and difficult to maneuver items.
  - 3. Batteries should be accessible for replacement and individually identified.
  - 4. All designs shall be conducted to ensure ease of maintenance and provide comfort to maintenance personnel. This shall include, but not be limited to, the following:
  - 5. The design shall be made so that routine testing and inspections are either automated or made through easily accessible, visible points. This includes accessibility to reapply corrosion protection treatments and windows for infrared scanning of power connections.
  - 6. The design shall be made so that inspection and cleaning requirements are minimized and can be conducted during properly scheduled maintenance periods
  - 7. The design shall pay special attention to the environmental impact due to possible breakdowns or failures and shall include measures to mitigate their impact. This shall consider equipment reliability and probability of failure, as well as economic mitigation costs.

### 1.5 SUBMITTALS

### A. General

- 1. Languages: English
- 2. All drawings and data shall be identified by the Owner's project name, job location, item identification and/or equipment number. The drawings shall contain revision boxes to describe revisions in full detail. Indication of the latest revision on each drawing shall be made by such means as a triangle-enclosed revision number.
- 3. Naming Convention. The Owner will provide a naming convention for the supplied equipment. All drawings and documents shall reflect the naming convention.
- 4. Electronic format.
  - a. File names shall be intuitive and clearly identify the document.
  - b. All documents are required to be provided as ISO Portable Data Format (PDF) files.
- B. Product Data:
  - 1. Mark submittal to show which products, sizes, options and accessories are applicable. If options and accessories are shown on product data or submittal, and are not

specifically indicated as excluded, options and accessories shall be assumed to be included.

- 2. Include the following information, as applicable:
  - a. Manufacturer's catalog cuts.
  - b. Manufacturer's product specifications.
  - c. Statement of compliance with specified referenced standards.
  - d. Testing by recognized testing agency.
  - e. Application of testing agency labels and seals.
  - f. Notation of coordination requirements.
  - g. Availability and delivery time information.
- 3. For equipment, include the following in addition to the above, as applicable:
  - a. Battery load tabulation and sizing calculations per IEEE Standard.
  - b. Wiring diagrams that show factory-installed wiring.
  - c. Printed performance curves.
  - d. Operational range diagrams.
  - e. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  - f. Remote monitoring provisions
    - 1) Network and communications protocols
    - 2) Modbus points lists, register addresses, and data formats
    - 3) Hard wired dry contact points available
- 4. Identifying symbols and equipment tags used on Contract Documents shall be clearly cross-referenced on the submittal.
- 5. Information on the submittals shall conclusively specify how submitted product compares with that specified as to material, capacity, stages, finish, color, accessories, working pressures, dimensions, insulation, and other characteristics specified in the Contract Documents
- C. Submittal.
  - 1. Technical Offer:
    - a. A narrative describing the proposed solution including any value engineering or alternative cost options.
    - b. Compliance-Deviation-Exception (CDE) for the main specification and all appendices to the specification.
      - 1) "C": By stating "compliance", the Manufacturer agrees to furnish the item or the feature as specified with no variation.
      - 2) "D": By stating "deviation", the Manufacturer proposes to furnish the item or the feature in a different way, while still meeting or exceeding the intended purpose of the product. The Manufacturer shall describe the reason for the deviation and the advantages/disadvantages of the proposed solution. Deviation should clearly reference specification section and line item. Stating deviation does not mean or imply acceptance by the Purchaser.
      - 3) "E": By stating "exception", the Manufacturer's intention is not to furnish the item, the feature or the services specified. The Manufacturer shall describe the reason for the exception. Exemption should clearly reference

specification section and line item. Stating exception does not mean or imply acceptance by the Purchaser.

- 4) If nothing is stated, it is assumed that the Manufacturer states "compliance". If there are contradictions in the statements, it is assumed that the statement that favors the Purchaser takes precedence.
- c. Progress Reports. Starting with Award, the Manufacturer shall submit simple Project Progress Report, on a monthly basis as a minimum and more frequently if required. Each report, shall contain the following, as a minimum:
  - 1) Progress during the period. Briefly describe the activities that have taken place during the period.
  - 2) Upcoming activities. Briefly describe upcoming activities and highlight action items required by the Owner, Contractor or Engineer.
  - 3) Percent complete for each part of the order.
  - 4) Project schedule status. Attach project schedule and highlight any significant changes that may impact the overall project schedule.
  - 5) Project change log. Document any changes to the scope of work.
- D. Project risks management and issues. Document any potential risks to the project including cost, schedule, quality, interface with other Suppliers and the Contractor, etc.
- E. Submittal Process. Manufacturer's drawings and design documents shall be submitted for approval using the project Document/Construction management system within 30 days of issuance of a purchase order. The Manufacturer shall proceed with fabrication or assembly of equipment only after approval of the drawings or authorization to proceed. The Owner reserves the right to make changes in requirements until the Supplier's drawings are returned approved. The Owner may provide partial approval to facilitate procurement of long lead time components, while finalizing detailed shop drawings. Submittal shall include as a minimum:
- F. Bill of Materials. A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the system. Bills of material shall include all items within an enclosure.
- G. Manufactured (integrated) product data.
- H. Drawings. Provide the following drawings as a minimum:
  - 1. Single line and three-line diagrams.
- I. Plans, elevations, sections and details showing dimensions, minimum clearances, entry provisions for field connections, gutter space, installed features and devices, weights, center of gravity, lifting and handling provisions and requirements, for each assembly specified. Specifications for the method of placing and anchoring the equipment to the building structure, including an indication of the highest UBC Seismic Zone for which anchorage method is rated.
- J. Power Cable Size and Termination Drawings for field connections.
- K. Product Data Sheets for each component. Include data on features, components, ratings, and performance.
- L. Factory Test Procedures. Submitted procedures shall be detailed and project specific.

- M. Preliminary Installation, Operation and Maintenance Instructions and Manuals.
- N. Installation Information: Installation, Operation and Maintenance Instructions and Manuals, relevant fabrication drawings, settings and calibration records shall be submitted by the Manufacturer. As a minimum the following items shall be provided:
  - 1. All information required for handling; installation; connecting of power, start up and commissioning; maintenance; and operation of the supplied equipment.
  - 2. Updated to "As manufactured" state shop drawing and other relevant information from Prior to Fabrication Submittal.
  - 3. Preventive maintenance schedule with detailed instructions and procedures for each maintenance activity.
- O. Final Acceptance Submittals. After commissioning and prior to taking over, as a minimum, the following items shall be submitted by the Manufacturer when required by the Contractor and the construction schedule, but no later than 30 days after commissioning of the equipment.
  - 1. Updated to "As built" state drawings and documents provided under Prior to Fabrication Submittal.
  - 2. Updated and final Installation, Operation and Maintenance instructions provided under Prior to Installation Submittals.
  - 3. Copies of completed factory and site testing reports including records of final settings and calibration.
  - 4. Equipment warranties and contact information for warranty matters.
  - 5. Final Compliance-Deviation-Exception (CDE) form listing the agreed in the contract deviations and exceptions and any additional deviations and exceptions based on the "as built" condition in both PDF and native format. Deviations and/or exemptions should clearly reference specification section and line item.

### 1.6 QUALITY ASSURANCE

- A. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- B. Testing Agency Qualifications: Member company of Inter-National Electrical Testing Association (NETA) or Nationally Recognized Testing Laboratory (NRTL).
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Regulatory Requirements:
  - 1. IEEE 1106-2015 IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications
  - 2. IEEE 1115-2014 IEEE Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications
  - 3. NFPA 70 National Electrical Code
- D. Conformity and compliance. Electrical Components, Devices, and Accessories shall be listed and marked as follows:
  - 1. North America: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Identify shipment with Company's purchase order number, Owner project name, and unit/tag number, following the project naming convention.
- B. Ship all equipment properly packed in tightly sealed, heavy gauge plastic or other type of liquid proof cover to protect the equipment from handling, shock, vibration, corrosion, rain, dust, and other foreign material.
- C. When assemblies are supplied that require disassembly for installation or are shipped disassembled, each piece of the subassembly so affected will be uniquely identified as to its assembly position.
- D. Box, crate or otherwise completely enclose and protect any loose components and spare parts. Clearly mark all equipment and provide complete installation instructions for any parts shipped separately from the main assembly. Adequately brace each shipping unit both internally and externally to prevent damage during shipping, handling, storage or in the process of erection.
- E. Clearly mark all shipping blocks, binding, etc. so that removal is assured. Identify any special precautions that must be observed when removing shipping constraints.
- F. Provide all shipping units with provisions for lifting and or skidding into place. Clearly mark all lifting points.
- G. Furnish unique installation materials and tools where required for the installation and commissioning of the equipment.
- H. Ship equipment by truck via direct dedicated carrier to job site. Coordinate the delivery with the installing contractor with proper notifications for status of delivery. Installing contractor will be responsible for unloading and placing equipment at its final location. Supplier shall be responsible for compliance with local trucking and delivery requirements.
- I. The Supplier shall be responsible for the repair or replacement at their expense of all damage due to improper preparation, packing or damage while in transport.
- J. The Contractor shall be responsible for receiving and storing the equipment until installation. The specified equipment shall be kept dry and clean. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

### 1.8 SITE CONDITIONS

A. System shall be designed for the Site Conditions. See Specification 01 81 16 Facility Environmental Requirements for site data and environmental conditions.

### 1.9 SEQUENCING AND SCHEDULING

- A. The Supplier shall be responsible to coordinate production, testing and delivery schedule with the Contractor, Engineer and the Owner to ensure on-time delivery of the equipment to match the construction schedule. The Supplier shall provide regular schedule updates and notifications for potential schedule delays.
- B. The Contractor shall provide up to date schedules to the Supplier on a regular basis and on a monthly basis as a minimum.
#### 1.10 WARRANTY

- A. Warranty the specified equipment and all other associated equipment (excluding batteries) as specified herein to be free from defects in materials, workmanship and non-performance per the requirements of this Specification for a minimum of 3 years after written acceptance by the Owner. In the event, any defects are discovered by the Owner within 3 years from acceptance of such equipment, the Manufacturer shall repair or replace, at Owner's option, defective products at no cost to the Owner. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.
- B. If at any time during the first three (3) years of commercial operation as defined below, the Owner shall accumulate sufficient evidence to reasonably indicate that the equipment or any part thereof is not in accordance with the specifications, the Owner will so notify the Supplier in writing, and the Supplier shall repair or replace the defective components. The cost of removal, reinstallation and complete re-testing of the equipment and any associated freight charges (via air ride truck) or service engineering charges, shall be at the Supplier's expense. The guarantee for the repaired or replaced equipment shall be extended for one year from the completion of repairs or replacement.
- C. If the equipment fails to meet the specific performance guarantees, the Supplier shall recommend to the Owner adjustments or modification. Upon approval by the Owner, the adjustments or modifications shall be made, and tests shall be rerun. The cost of these adjustments or modifications and complete re-testing shall be made at the Supplier's expense. After such adjustments or modifications, should the equipment fail to achieve the guaranteed performance, an equitable settlement shall be made which may, without limitation, include an adjustment of the contract price.
- D. Complete re-testing, as referred to in this section shall mean site acceptance testing as stipulated in testing portions of this specification including commissioning activities. The conditions that apply to original testing requirements shall also apply to the re-testing of any equipment performed under the conditions of this guarantee. The cost of this re-testing shall be made at the Vendor's expense.
- E. Commercial operation is defined as commencing on the date on which the equipment covered by these specifications has successfully completed final site acceptance testing and has received written acceptance by the Owner.
- F. Furnish warranty covering all costs for repair, parts, labor, testing equipment, travel, and living expenses for the manufacturer's service personnel. Performance of warranty work shall not be restricted to normal working hours but shall be at the Owners choosing including overtime and weekend hours at no additional cost to the Owner.
- G. Service Response Time required to provide service on a 24-hour, seven days a week basis by a factory trained field service engineer with:
  - 1. Phone Support within 2-hours of initial call by Owner or owner's representatives
  - 2. On-site support within 24 hours of initial call by Owner or owner's representatives
  - 3. Be fully capable of providing high-quality, factory-trained service personnel and Manufacturer-certified replacement parts.
  - 4. All service reports shall be provided to the local site facilities engineer within 2 weeks of any site visit.

# 1.11 SYSTEM START-UP AND COMMISSIONING

- A. Commissioning Levels:
  - 1. Level 1 Factory Tests
    - a. Factory Acceptance Test The Supplier is responsible for developing and implementing all tests to ensure that equipment quality is maintained prior to delivery to the Owner site and to confirm the Owner equipment specification requirements are confirmed and documented.
    - b. Factory Witness Test None required.
  - 2. Level 2 Equipment Installation the General Contractor (GC) shall have processes to ensure the equipment is received, stored, installed and made ready for the equipment Supplier to perform their site startup.
  - 3. Level 3 Supplier Startup the equipment Supplier shall have procedures and methods to ensure the equipment is started, adjusted and performance is validated on site.
  - 4. Level 4 Equipment Specific Commissioning The Supplier, GC and Owner CxA shall coordinate the validation of the installed equipment. The CxA shall direct the commissioning test with the assistance and support of the GC and the Supplier.
  - 5. Level 5 Integrated System Testing The Owner CxA shall develop tests that ensure multiple systems, subsystems and components work as integrated systems. The GC and Supplier(s) shall assist and support these tests.

# 1.12 MAINTENANCE

- A. Extra Materials and Spare Parts
  - 1. Manufacturer to develop list of recommended extra materials and spare parts. List to include per unit pricing.
- B. Maintenance Service
  - 1. Manufacturer to develop recommended maintenance schedule and procedure with detailed instructions. Include optional pricing for annual cost of service.

# PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
  - A. Manufacturers: Subject to compliance with requirements, provide products by the following: 1 Flooded Lead-acid Batteries

Туре	Manufacturer	Model Line	
Vented or	C&D	DCU	
Flooded Lead		DJ	
Acid (VLA)		JC	
, <i>,</i>		KCR	
		LCY	
		LCR	
	Alcad	LSe	
		SGL/SGH	
		SD/SDH	
	BAE	OGi	
	1-5-14-94-949	OPzS	
	Enersys	OPzS	
		Powersafe CC	
		Powersafe EC	
		Powersafe FC	
		Powersafe GC	
		Powersafe Plante	
	SBS	STT	
		SR	
	Hoppecke	GrOE	
	200	OSP	
		OPzS	
	GNB	MCX/MCT/H1T	
		NCX/NCN/NCT	
	-	PDQ/ T-Bloc	
Nickel Cadmium	Alcad	LE	
(Ni-Cad)		M	
		Н	
	SBS	KP	

- 2. Battery Chargers (Or Approved Equal)
  - a. Hindle: ATEVO
  - b. LaMarche
  - c. Saft
  - d. Sens

# 2.2 BATTERY SYSTEM SELECTION AND SIZING

- A. The battery selection shall be for applications as follows:
  - 1. The battery is a redundant, two independent battery systems.
  - 2. The battery is normally on float charge.
  - 3. The battery duty is for switchgear protection and control logic power and to perform breaker trip, close, and MV breaker spring operator charging motor operation.
  - 4. The demand is typically high current over short periods, usually less than 30 minutes in duration. The applications can have frequent or infrequent discharges.
  - 5. Each battery alone shall be designed to support continuous load for the duration followed by the number of cycles of open-charge-close of all connected breakers without battery charger support in accordance with Appendix A. This duty shall be the battery acceptance criteria upon installation.
  - 6. The battery system shall be sized to support all of the MV switchgear loads shown in the single line diagrams in the Drawings, taking into account the actual type of vacuum circuit breakers that are to be provided, i.e. ABB AMVAC solenoid type breakers or standard spring-motor charging type. Switchgear provider shall be responsible for the sizing.
- B. Battery sizing calculation based on IEEE Std 1115-2000 and minimum discharge rate per Appendix A using manufacturer software.

- C. An aging factor and design margin in accordance with Appendix A shall be applied and shown in the calculations.
- D. Battery shall provide 100% rated capacity upon delivery to be verified at Site Acceptance Testing by the Owner's Cx Authority.
- E. A detailed itemization of all connected loads and design load Amperes, both momentary and continuous shall be included in the calculation. Design loads shall include all switchgear loads and other customer designated loads to be connected to the battery system. Vendor shall confirm all loads before final battery selection.
- F. On failure of the AC supply to charger, the battery shall be capable of supplying the specified continuous load for a minimum of 12 hours, during which time the battery shall have sufficient discharge capacity to perform sequential closing-tripping operations of all circuit breakers for at least two consecutive times (one circuit breaker at a time). The system shall also be capable of simultaneous tripping of all circuit breakers within switchgear at the end of the cycle.
- G. Charger sizing calculation based on battery size with recharge time in accordance with Appendix A with the charger supporting the continuous system load and recharging of the battery at the same time.

# 2.3 BATTERIES

- A. Each battery shall be the smallest footprint possible of the flooded, 20-year Lead-acid type with the following:
  - 1. Translucent polypropylene cell container
  - 2. Insulating protective cover over top terminals
  - 3. Polypropylene flame-arresting vent caps
  - 4. Internal steel grid with pockets containing active plate material.
  - 5. Plates internally welded to form the internal bus bar assembly.
  - 6. Separation between plates provided by injection molded plastic separator grids providing edge insulation and plate separation.
  - 7. The seal between the cover and post terminal shall be provided by a compressed oring or elastic sealing surface and compression locking method to provide a life-time leak-proof seal.
- B. The battery shall be supplied fully charged, with all necessary intercell connectors, plastic covers and flame arrestor vent caps.
- C. Stacked batteries with Front terminals are preferred.
- D. Provide plastic guards over all exposed live parts.

#### 2.4 BATTERY CHARGERS

- A. Provide one battery charger each station battery. Each battery charger shall be powered as described in Appendix A. The unit shall be equipped with an input circuit breaker, two or three pole interrupting rating per Appendix A and a two-pole output DC circuit breaker. It shall be electronically current limited and shall automatically regulate voltage per Appendix A. The charger shall have a DC voltmeter and DC ammeter accuracy in accordance with Appendix A, and shall be housed in a front access wall mounting NEMA 1 enclosure.
- B. Battery charger shall have an alarm board which has latching LED lights and auto reset relays with dry form C contacts for the following:

- 1. Low DC voltage (red)
- 2. High DC voltage (red)
- 3. AC input voltage failure (red)
- 4. Rectifier failure (red)
- 5. Float mode (green)
- 6. High rate (amber)
- 7. DC output failure with contacts for remote alarm (red)
- 8. Ground detection alarm (red)
- 9. Summary alarm of all of the above
- C. The charger shall have a fully automatic equalize charge timer. After an outage per the specified time, the charger shall automatically go into a boost charge voltage mode for a preset interval. At the end of this period, the charger shall automatically return to float. The charger shall restore the batteries after a complete discharge. All durations to be in accordance with Appendix A.
- D. Provide DC output filtering.
- E. Monitoring and Communications
  - 1. The battery charger shall provide the following information via Modbus TCP/IP via a single Ethernet connection to the MVGPS PLC.
  - 2. Meters
    - a. Voltage
    - b. Current
    - c. Equalize time remaining
    - d. Battery temperature
  - 3. Setpoints
    - a. Float voltage
    - b. Equalize voltage
    - c. Equalize time
    - d. Current Limit
    - e. High DC Voltage
    - f. Low DC Voltage
    - g. High DC Shutdown Enabled
  - 4. Status
    - a. Temperature probe installed
    - b. Forced load share enabled
  - 5. Charger mode
    - a. Float
    - b. Equalize
  - 6. Equalize method
    - a. Manual
    - b. Timer
    - c. Auto
  - 7. Alarms
    - a. High DC voltage
    - b. Low DC voltage
    - c. DC output failure
    - d. AC input failure
    - e. Positive ground fault
    - f. Negative ground fault

- g. High DC voltage shutdown
- h. Common alarm relay
- 8. Error number code self diagnostics

#### 2.5 BATTERY RACKS AND ACCESSORIES

- A. The battery and the battery rack shall be certified for the seismic requirements of the project installation. Manufacturer shall provide seismic restraint calculations and details and provisions on the racks for anchoring and bracing to structure as required. Rack shall be certified for IEEE 693, High Seismic Zone (UBC Certification is not accepted)
- B. Provide steel battery racks, quantity and configuration as noted or required. Racks shall be painted with ANSI 61 gray alkali and acid resistant paint. The rack shall be equipped with plastic rail insulation covers.
- C. Battery cables shall be copper Type DLO with EPR insulation for all inter-tier connections. Intercell connections shall be lead or nickel coated copper bar. Battery supplier shall provide a layout drawing showing the detailed inter-cell connectors, inter-row connectors, and intertier as appropriate.
- D. Battery racks shall allow for any cell to be replaced without disassembly or removal of interfering structure or other cells. Additionally, maintenance of each cell shall be possible without interference from other structures, placement of the battery racks, or other cells.

#### 2.6 SPILL CONTROL AND ACCESSORIES

- A. Containment: System shall be 4 inches high and extend 1 inch beyond the furthest point of the rack. Components shall be available in 1-inch increments. System shall be liquid tight. All system components shall be completely free of Volatile Organic Compounds. System shall be capable of withstanding a 92-ft-lb impact without losing liquid-tight integrity. The barrier must have checkerboard yellow black markings indicating caution, to alert employees or service personnel to potential hazards of the batteries. Markings must meet OSHA safety color code requirements.
- B. Installation: System shall not require drilling into the floor and shall be capable of being installed on concrete, composition tile, and other common battery room floor substrates. Any uncommon tools required for proper installation shall be made available by the manufacturer. Installation instructions shall be provided such that any qualified, licensed contractor may install spill control system. No routine maintenance shall be required for continued effectiveness.
- C. Rack Coordination: Spill control system shall be applied on top of, or around the rack frame and shall not be installed underneath any part of the rack that touches the floor. In areas other than Seismic Zone 0, no component of the spill control system shall be inserted between the rack frame and the floor that could introduces a spring value.
- D. Neutralization: Provide absorption and neutralization mats in the quantity necessary to cover the entire area inside the system plus 10 percent. Mats shall be capable of neutralizing electrolyte to a pH of 7.0 to 9.0 and contain color indicators to differentiate between acidic and non-acidic exposures. Mats shall neutralize 100 percent of absorbed acids.
- E. Fire Safety: The fire safety characteristics of the mats shall be verified by at least two satisfactory test results from an independent A2LA accredited laboratory. Approved test protocols: ASTM E 648-99, ASTM E 1354-99, UL-94 HBF, and NFPA 701-1999.

- F. Aisle Mats: Battery room shall be equipped with aisle mats, which are electrically insulation, acid resistant, skid resistant, and perforated to drain electrolyte. Mats shall have beveled edges and shall be easily field modified to specific aisle dimensions. Mats should be sized to match or exceed the length of the spill containment. Electro-static dissipation gear shall be provided. Mats shall pass UL 94 HB.
- G. Vendor: Spill containment and neutralization equipment must be supplied by the original manufacturer. Approved vendor for spill containment and safety accessories shall be Acran or approved equal.

#### 2.7 DC PANEL BOARD

- A. Provide Schneider Electric DC rated panelboard with:
  - 1. Main lugs only
  - 2. Sized as required with 225A busing minimum.
  - 3. All required branch breakers to provide dedicated circuits to each end of the switchgear, the generator paralleling sections, the 15KV switchgear.
  - 4. Full selective coordination of the branch breakers with the main output breakers of the Battery bank and the power supply. Bussmann fused panelboard may be used.

#### 2.8 THERMAL RUNAWAY DEVICE

- A. Provide Cellmatrix battery monitoring site control unit with float current CT's on each battery rack output feeder, one ambient temperature sensor and two temperature sensors, on battery jars. Provide all other accessories as required, such as current measurement Interface (CMI), temperature measurement Interface and aggregator (RIM), etc.
- B. Provide one monitoring system per each battery string, each with one Ethernet enabled controller to connect to the MVPSG PLC for monitoring of the thermal runaway system.
- C. Control power for the unit shall be supplemented from an external 120V, 20A field branch circuit
- D. Alarm event to trip open only the associated battery strings DC output breaker.

#### 2.9 SOURCE QUALITY CONTROL:

- A. The Owner, and its representatives shall have the right to inspect all equipment covered by this Specification at any time and to witness any tests made on the equipment. The Manufacturer shall notify the Owner in writing at least 10 working days prior to shipment to permit the Owner the option of inspecting the equipment at the factory.
- B. The Battery Manufacturer shall test 100 percent of the battery cells at 100 percent of their rating for the reserve time and final voltage required. Manufacturer shall submit copies of certified test reports to the Engineer for final review and approval.
- C. Test and record the voltage and internal resistance for each battery after testing prior to shipment.
- D. Manufacturer's shall keep detailed records of all testing procedures and results and submit certified copies as part of the shop drawing submittal.
- E. Report test results. Include the following data:
  - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.

- 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
- 3. List of instruments and equipment used in factory tests.

### PART 3 - EXECUTION

#### 3.1 SYSTEM INTEGRATION

- A. The equipment supplied herein shall interface with equipment from other Suppliers to form a fully integrated, functional, resilient and concurrently maintainable power system. The Vendor shall liaise with the other equipment Suppliers to coordinate the interface with their systems, provide necessary technical information and ensure a fully integrated power system.
- B. The Station Battery System Vendor shall coordinate with the MVGPS System Supplier, to provide the MODBUS TCP/IP point maps and the Ethernet interface to facilitate integration of the Station Battery System into the control and monitoring systems provided by other Suppliers.
- C. The Station Battery vendor shall produce wiring organization and documentation, for those controls required between the Station Battery System and equipment supplied by others.
- D. The Station Battery Vendor shall participate in the coordination of external control power sources.
- E. The Station Battery Vendor shall be responsible for coordination with the Contractor and Engineer for scheduling all testing and construction administration activities as required.

#### 3.2 INSTALLATION

- A. The Vendor shall provide installation instructions and assist the Contractor with the interpretation of the instructions and provide installation clarifications as required.
- B. Install station battery racks and equipment in accordance with the Contract Documents and approved layouts.
- C. All equipment and materials shall be installed according to the manufacturer's instructions.
- D. In addition to the Manufacturer's instructions, the Contractor shall comply with the following:
  - 1. Examination
    - a. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the Station Batteries.
    - b. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 2. Preparation
    - a. Floor mounting location needs to be prepared within the manufacturers requirements for installation.
    - b. Floor elevation and support to be in accordance with manufacturers requirements.
  - 3. Equipment Mounting: Install Station Batteries on leveled finished floor.
    - a. For supported equipment, install epoxy-coated anchor bolts and anchor into structural concrete floor.
    - b. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

- c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 4. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and applicable codes and standards.
- 5. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- 6. The Contractor shall exercise extreme care in the protection of Station Battery equipment during installation. At no time shall personnel be allowed to sit or stand on equipment enclosures or use them as support for working above. Internal components shall be kept clear of dust, filings and other construction debris.
- 7. Temporary Heating: Apply temporary heat to the equipment, according to manufacturer's written recommendations, throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.
- 8. Efforts shall be implemented to protect the equipment from dust and dirt during transport, storage and installation, due to the construction environment. Station Battery System should be protected / covered when there is no active work on the unit during installation.
- 9. Cleaning: Inspect interior and exterior of installed equipment. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. The equipment shall be given a thorough cleaning prior to final testing.
- 10. Equipment Maintenance: Equipment is to be maintained to the manufacturers recommendations during commissioning process. Manufacturer to provide equipment storage, handling, and maintenance information prior to shipment
- E. Battery racks shall be fully assembled and anchored in accordance with the manufacturer's requirements and seismic design calculations before loading.
- F. Battery racks shall be bonded and grounded in accordance with the Contract Documents and (1) #6 AWG CU minimum to nearest ground bus.

# 3.3 MANUFACTURER'S FIELD SERVICE

- A. Maintain a local competent service organization, capable of providing quality service and replacement parts. Availability and response times and additional service requirements shall be as specified in other sections.
- B. The Vendor shall attend a schedule coordination meeting at the site prior to start of construction for the purpose of integrating installation schedule of other Suppliers and the Contractor.
- C. A qualified manufacturer's field representative shall be on-site at the start of construction to observe installation of Station Battery System, inspect, test, adjust components and assemblies.
- D. During Station Battery startup and if repair required, field service must be unlimited and must continue until satisfactory system operation and Engineer's approval has been achieved.
- E. The time for on-site support through construction and commissioning period shall be indicated in the scope of work and base bid price.

### 3.4 FIELD QUALITY CONTROL

- A. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner. The Purchaser/Owner reserves the right of rejection at the job site if the above conditions are discovered even after acceptance at the factory.
- B. Testing Agency: The Owner will engage a qualified Commissioning Agent to perform tests and inspections. The Station Battery Vendor shall be responsible for assisting the Commissioning Agent and supporting all the site tests as necessary.

#### 3.5 SITE TESTING AND COMMISSIONING OF STATION BATTERIES

- A. General Requirements
  - 1. Provide installation and startup checklists to the Owner and General Contractor for their review and acceptance, prior to commencing Level 4 Commissioning.
  - 2. Review and comment on Level 4 testing scripts provided by the Commissioning Agent.
  - 3. The Contractor shall provide electrical trade labor for site tests. The Contractor shall provide meters, load banks, cables and electrical materials external to the Station Battery system required to conduct these site tests.
  - 4. CxA to submit test procedures for commissioning. Test procedure to be reviewed by the Engineer and Manufacturer.
  - 5. Coordinate with the Engineer and Owner all testing times and dates. Notify the Engineer, and Owner's Representative a minimum of 14 days before the start of site acceptance testing.
  - 6. Perform all tests without making adjustments to the system during the test. Failure of any component or system will require the components to be replaced or repaired and all tests repeated.
  - 7. The site acceptance tests must be conducted in the presence of the Electrical Contractor and the General Contractor. The Owner, the Architect/Engineer and the CxA may also request to be present.
  - B. Equipment Installation (Level 2 Commissioning)
    - 1. Upon delivery, inspect equipment for:
      - a. Equipment shipped matches the equipment tested during Level 1 FAT
      - b. There are no alterations to the equipment after Level 1 FAT
      - c. There is no damage to the equipment from transportation
      - d. Confirm the tilt, shock and vibration devices show no abnormal shocks or tilts during transit.
    - 2. After installation, check and verify:
      - a. Equipment installed in accordance with the Manufacturer's requirements Complete installation and startup checks according to manufacturer's written instructions.
      - b. Equipment installed in accordance with drawings, plans and specifications.
      - c. Installation is compliant with local codes and standards and health and safety requirements.
      - d. Equipment is accessible for operation and maintenance.
      - e. Perform visual and mechanical inspections on the complete Station Battery installation.

- f. Verify that electrical wiring installation complies with manufacturer's submittal and with written installation requirements in other electrical Sections.
- C. Vendor Startup (Level 3 Commissioning)
  - a. Develop and update check lists and scripts for Level 3 Testing
  - b. Verify connections and integration with the input and output connections and load banks.
  - c. Set field-adjustable settings in accordance with Engineer approved parameters.
  - d. Power up and verify operation of each battery charger.
  - e. Verify that all status lights, alarm lights, audible alarms, meters, and other operational devices are functioning properly.
  - f. Functional check of the battery charger and the best battery selector.
  - g. Verify operation of hardwired and Ethernet interfaces. Confirm proper communication and readings at MVGPS PLC. Provide alarm logs confirming points tested.
  - 2. Complete NETA Acceptance Testing shall be performed on the battery installation in accordance with the current NETA ATS including, but not limited to, the following:
    - a. Visual and Mechanical Inspection
    - b. Ventilation
    - c. Safety requirements
    - d. Compare equipment nameplate data with drawings and specifications.
    - e. Inspect physical and mechanical condition.
    - f. Verify battery support racks or cabinets, mounting, battery spill containment system, anchorage, alignment, grounding, and clearances.
    - g. Verify electrolyte level. Measure pilot-cell electrolyte temperature.
    - h. Verify the units are clean.
    - i. Verify application of an oxide inhibitor on battery terminal connections.
  - 3. NETA Electrical Tests
    - a. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter.
    - b. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
    - c. Verify all charger functions and alarms.
    - d. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
    - e. Measure intercell connection resistances.
    - f. Perform internal cell resistance measurements.
    - g. Perform a load test in accordance with manufacturer's published data or ANSI/IEEE 1106.
- D. Functional System Testing (Level 4 Commissioning)
  - 1. Reference Division 26 Electrical Systems Commissioning Requirements for testing additional testing information, roles, and responsibilities.
  - 2. Per section 1.10 Warranty, if the equipment fails to meet listed specifications and performance re-testing shall be performed at Manufacturers expense.
  - 3. Commissioning tests:
    - a. MVGPS PLC Connectivity and Status Verification.
    - b. Station Battery Functional Test

- 4. CxA to provide list of indications, parameter values, and system responses considered satisfactory for each test action. Included will be tabulation of actual observations during test.
- 5. Per PG&E requirements, after battery is installed, perform and provide proof of discharge testing (3 hour load testing is typical) to ensure battery has the capacity to support the load and trip, per IEEE Std 450-2010 (Voltage measurements should be taken every 15 minutes throughout the testing).
- E. Level 5 Integrated System Testing (IST)
  - 1. Following the completion of all system and component testing and before applying critical load to the system an overall Integrated System Test (IST) will be conducted on the complete critical electrical distribution system.
  - 2. Upon completion of the Level 4 Station Battery acceptance tests, the Vendor shall participate in an Integrated Systems Test (IST) in which the Station Batteries will be tested as an integral part of the overall facility, to verify compatibility with the other mechanical and electrical systems. The participation shall include:
    - a. Review and approval of integration test procedures produced by the Engineer or Commissioning Agent, and assurance to the Owner that such tests will not be destructive or void warranties.
    - b. Attendance at test scheduling meetings, or provision of information as required by the Contractor to properly schedule the Vendor's activities through the testing period.
    - c. Presence of Vendor's technicians during systems integration testing when such tests heavily involve the Station Battery System.
  - 3. Reference Division 26 Electrical Systems Commissioning Requirements for testing additional testing information, roles, and responsibilities.
  - 4. Per section 1.10 Warranty, if the equipment fails to meet listed specifications and performance re-testing shall be performed at Manufacturers expense.

# 3.6 ELECTRICAL FIELD TEST REPORTS

- A. The Manufacturer, Supplier and independent testing agencies shall supply their certified test reports and data for each of the factory and site tests conducted by them as specified herein.
  - 1. Test Reports
  - 2. All test data shall be recorded and certified by the Manufacturer or testing agency conducting the aforementioned tests. Any defects noted during the tests performed shall be brought to the attention of the Engineer for corrective action. Submit electronic and three (3) hard copies and soft copies (.pdf format) of all test reports for approval and/or corrective actions.
  - 3. Each test report set submitted shall be clearly identified by the Purchaser's name, the project name, the purchase order numbers, the equipment description and specific identification, and the manufacturer's name and address. Each individual document shall be legible and shall have reproducible capability.

# 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the Station Batteries and associated equipment.
- B. Engage a qualified trade or manufacturer's representative to provide the instructions on each major piece of equipment. This trainer may be the start-up technician for the piece of equipment, the installing contractor, or a manufacturer's representative. Trainers shall be

factory-trained and authorized. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. Specifically, the trainer must have site specific knowledge as well as general knowledge of the system. More than one party may be required to execute the training.

- C. The battery vendor shall provide an on-site training session for the Owner's operations staff on the recommended operations and maintenance practice associated with the battery installation. The training shall be a minimum of 4-hours and shall include the following:
  - 1. Orientation on the hazards associated with the battery installation and the proper safety equipment and practices including:
    - a. Battery and electrolyte chemistry, MSDS explanation, and emergency procedures.
    - b. Orientation on the spill containment and neutralization products, proper installation and maintenance, procedures to follow upon battery cell leak or damage or electrolyte spill.
    - c. Guidelines on disposal and replacement of products.
    - d. General guidelines regarding the proper procedures and equipment relative to the 125 VDC system and equipment.
  - 2. Setup, orientation, and procedures relating to the battery system, Power supply, Best Battery diode and battery chargers, setpoints, and alarms.
  - 3. Best battery selector.
  - 4. Purpose and function of the equipment
  - 5. A brief working knowledge of the operating theory of the equipment
  - 6. Submittal drawings, catalog data, and O&M manual content and organization
  - 7. Available parts lists, including recommendations regarding parts that should be readily available and stored on site
  - 8. Local representatives for service, parts, and repair, including contact information
  - 9. Daily, weekly, monthly, quarterly, semiannual and annual routine preventative maintenance requirements and procedures
  - 10. Normal and major repair procedures
  - 11. Identify location of all related equipment power disconnect switches, fuses and circuit breakers
- D. Training Plan Submittals & Timing
  - 1. Develop a preliminary training plan outline and schedule of training dates and submit to the Owner's Representative for review and approval a minimum of 60 days before the planned training sessions.
  - 2. Once the training plan outline is approved, submit one complete set of lesson plans, training manuals, handouts, visual aids and reference material organized in tabbed binder(s) to the Owner's Representative for review and approval a minimum of 30 days before the planned training sessions.
  - 3. Provide training materials to Owner's Representative 7 days before the planned training sessions. Provide one set of materials for each trainee as directed by Owner, up to a maximum of 10 copies. Additional copies shall be provided at the cost of reproduction without mark-up if requested by Owner's Representative.
  - 4. Provide an Attendance Sign-in sheet as part of the training submittal package.
  - 5. Provide final training materials in electronic format copied to optical disk capable of being stored on a servers without loss of fidelity or organization. All documents shall be bookmarked for the sections as indicated above.
- E. Training Video

- 1. Owner shall be authorized to record all demonstration and training sessions at Owner's option and expense.
- 2. Video materials shall be provided in a format that allows for transfer to network storage and seamless access from internal cloud sites.
  - a. General guidelines regarding the proper procedures and equipment relative to the 125 VDC system and equipment.
- 3. Setup, orientation, and procedures relating to the battery system and battery chargers, setpoints, and alarms.
- 4. Best battery selector.
- 5. Inspection and maintenance of the battery cells, monitoring and maintaining electrolyte levels, monitoring cell voltages.
- 6. Proper record-keeping practices of battery activity and maintenance.

# END OF SECTION

Description	Unit	Rating			Remarks		
I. General							
Battery Type		Lead-Acid				High Discharge Rate	
Nominal Voltage	V	125 VDC					
Minimum Voltage	V	105 VDC					
Maximum Voltage	V	140 VDC					
Special Battery Warranty	-	Twenty Five (25) years five (5) years full warranty (full replacement) and Twenty (20) years prorated at 1.25 aging factor				80% rate minimum	d capacity
Warranted Cycle Life	-	Discharge Rate	Discharge Duration	Disch End Voltag	arge ge	Cycle Life	Based on annual average
			8 hours	1.14 cell	per	40 cycles	battery temperature
		30 1.14 per minutes cell		125 cycles	of 77 deg F (25 deg C).		
			15 minutes	1.14 cell	per	170 cycles	Provide discharge rate data.
Battery Type	-	Lead-acid			Alkaline Potassium (KOH)	Solution – Hydroxide	
DC Cutoff Voltage (End Voltage)	V	Minimum 1.67 V per cell					
DC Float Voltage	V	2.25 Volts per cell					
Specific Gravity	-	1.26 at 25 degree C			No output de lagging to Power Factor	ration for 0.85 0.85 leading r allowed.	
Battery Continuous Load Duration	Hrs	4 Hrs			Each Battery		

# APPENDIX A: STATION BATTERY RATINGS

Description	Unit Rating		Remarks
Switchgear Breaker		4-cycles of open-charge-close of all	
Operations		connected breakers	
Battery Discharge Rate	Hrs	8 Hrs minimum	
Aging Factor		1.25 and design margin of 1.1	
Battery Recharge	Hrs	12 Hrs	
Time			
II. Battery Charger			
Input Voltage	V	Single or three phase 480 VAC	
Input Frequency	Hz	60 Hz	
Breaker Rating	kA	25 kA	2 or 3 pole AC breaker
Voltage Regulation	%	0.5 % for 0-100% load	
Input Line Voltage Variation	%	± 10%	
Output Voltage	V	125VDC	
DC Ammeter	%	2%	
Regulation	,.	_ / 0	
Equalize Charge Timer Range	Hrs	0 – 24 Hrs	Low temperatures affect charging, this should be automatically compensated by raising the float charge
Outage Time to Initiate	sec	30 sec minimum	and not onalgo
Battery Re-Charge Time	Hrs	12 Hrs after complete discharge	
III. Best Battery			
Operating Voltage	V		
Voltage Pating	V	300 VDC minimum	
Current Rating	V 0/2	150% of maximum continuous	
	70	battery design current.	
IV. Power Supply			
Input Voltage	V	Single or three phase 480 VAC	
Input Frequency	Hz	60 Hz	
Breaker Rating	kA	25 kA	2 or 3 pole AC breaker
Voltage Regulation	%	0.5 % for 0-100% load	
Input Line Voltage Variation	%	± 10%	
Output Voltage	V	125VDC	
DC Ammeter Regulation	%	2%	

# APPENDIX B: TEST RESULT CRITERIA

No.	I. Factory Witness/Acceptance Tests				
1.	Test Description	Criteria			
2.	Electrical Testing	In accordance with Manufacturers published results			
3.	Sound Level	Comply with IEEE C57.12.91 and NEMA ST 20			
	II. Level 3 Commissioning Tests				
	Test Description	Criteria			
4.	Electrical Testing	In accordance with Manufacturers published results			
5.	Electrical Testing	In accordance with NETA Standards			
	III. Level 4/5 Commissioning Tests				
6.	Test Description	Criteria			
7.	Electrical Testing	In accordance with Manufacturers published results			

END OF APPENDICES

# Third Party Interconnection Battery Information Sheet and Acceptance Document

Section 1: To be completed by Station Battery Vendor while providing all pertinent information and documentation for review based on Appendix T of the TIH or PG&E document TD-2999B.

Project Name: <u>ATASCADERO STATE HOSPITAL</u>Site: <u>10333 EL CAMINO REAL,</u> <u>ATASCADERO</u>

Type of Interconnection/project: Primary ServiceDate:(Transmission, Distribution, Primary Service, Relay Replacement, etc.)

# 1A) - Battery

Dattory	
Is Battery Flooded type or Sealed	
Туре	
Battery Manufacturer	
Battery Size.	
Battery Model No.	

# 1B) Charger

Charger Size	
Charger Model No.	

#### 1C) Rack

Is Rack Certified for IEEE 693, High	
Seismic Zone (UBC Certification is	
not accepted) –	
Rack Manufacturer and Model No.	

# 2- List of DC Loads

Is list and quantity of DC Loads included with the Submittal?	
---	--

#### **3-Battery Sizing Calculation**

Is Battery sizing sheet based on IEEE 485-1997 or IEEE 1115-	
2000 included with the Submittal.	

# 4 – Proof of Discharge Testing

Is proof of Discharge Testing included with this Submittal

# 5 – Maintenance

Are	maintenance	schedule	and	procedure	included	with	this
Sub	mittal						

# 6 – Battery Low Voltage Monitoring

Are details included with this submittal for 24/7 monitoring of Low	
DC Voltage. – Please specify Yes or No	
Remote monitoring is required for unmanned Sites	

# Section 2: To be completed by PG&E Substation Engineering Department

# Third Party Interconnection Battery Acceptance Document

Date: 03-18-22 Rev 6

Name of Customer: CITY OF SAN LUIS OBISPO JO#: 35060141 Distribution engineer or PM: Esteban Macias Reviewed by: Arshad Hasan

Item 1: Type of Utility Grade Battery -

Item 2. Detailed Load Information -

- Item 3. Battery & Charger Sizing Calculations -
- Item 4. Proof of 3hr-Discharge Testing -
- Item 5. Maintenance Procedures

#### Item 6. Monitoring of Minimum Battery Voltage

(Ensure battery DC low voltage is monitored as this will be verified during the Pre-Parallel inspection).

Thank you,

Substation Project Engineering

#### LED INTERIOR LIGHTING

#### 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 the following types of LED luminaires:
  - 1. Cylinder.
  - 2. Downlight.
  - 3. Linear industrial.
  - 4. Recessed, linear.
  - 5. Strip light.
  - 6. Surface mount, linear.
  - 7. Surface mount, nonlinear.
  - 8. Suspended, linear.
  - 9. Suspended, nonlinear.
- B. Related Requirements:
  - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

- B. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals:
- D. Samples: For each luminaire and for each color and texture with standard factoryapplied finish.
- E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
  - 1. Include Samples of luminaires and accessories involving color and finish selection.
- F. Samples for Verification: For each type of luminaire.
  - 1. Include Samples of luminaires and accessories to verify finish selection.
- G. Product Schedule: For luminaires and controls. Use same designations indicated on Drawings.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Luminaires.
  - 2. Suspended ceiling components.
  - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
  - 4. Structural members to which luminaires will be attached.
  - 5. Initial access modules for acoustical tile, including size and locations.
  - 6. Items penetrating finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Ceiling-mounted projectors.
    - g. Fire alarm devices
  - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.

- E. Product Test Reports: For each type of luminaire, for tests performed by a qualified testing agency.
- F. Sample warranty.

# 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

# 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. Diode modules: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

# 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
  - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

# 1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### 1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Lighting levels shall conform to Illuminating Engineering Society of North America (IESNA) standards (see the IESNA Lighting Handbook: Reference & application or the IESNA Lighting Ready Reference). For any luminaire substitutions for any space. A photometric study is required to ensure the minimum lighting levels are met for each application category.
- C. Seismic Performance: Luminaires, diodes and drivers shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- D. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C)
  1. Relative Humidity: Zero to 95 percent.
- E. Altitude: Sea level to 1000 feet (300 m).

# 2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electrical Code, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended diode module labeled or stamped with serial number and factory reorder codes. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when diodes are on.
  - 1. Label shall include the following lamp characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Diode type, lot and manufacturer, milliamps or wattage, and other pertinent reorder information.
    - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

- F. California Energy Code Title 24 compliant.
- 2.3 LUMINAIRE REQUIREMENTS.
  - A. Nominal Operating Voltage: 120/277 V ac. Multi voltage.
  - B. Diode:
    - 1. Minimum allowable efficacy of 80 lm/W.
    - 2. CRI of 90 minimum. CCT of 3500K.
    - 3. Rated diode life of 70,000 hours to L70.
    - 4. Dimmable from 100 percent to 1 percent of maximum light output. (where dimming is indicated)
    - 5. Internal driver.
    - 6. User-Replaceable diode modules. Lens Thickness: At least 0.125-inch (3.175mm) minimum unless otherwise indicated.
  - C. Housings:
    - 1. Galvanized stamped steel housing and steel or aluminum heat sink.
    - 2. Clear finish.
    - 3. Universal mounting bracket.
    - 4. Integral junction box with conduit fittings.
  - D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit replacing of the LED modules and drivers in the field. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacing of LED modules and drivers and when secured in operating position.
  - E. Diffusers and lenses:
    - 1. Fixed lens.
    - 2. Wide light distribution.
    - 3. Optical grade silicone
    - 4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - 5. Glass: Annealed crystal glass unless otherwise indicated.
    - 6. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
  - F. Standards:
    - 1. ENERGY STAR certified.
    - 2. RoHS compliant.
    - 3. UL Listing: Listed for damp location.
    - 4. Recessed luminaires shall comply with NEMA LE 4.

# 2.4 MATERIALS

- A. Metal Parts:
  - 1. Free of burrs and sharp corners and edges.
  - 2. Sheet metal components shall be steel unless otherwise indicated.
  - 3. Form and support to prevent warping and sagging.
- B. Steel:
  - 1. ASTM A36/A36M for carbon structural steel.
  - 2. ASTM A568/A568M for sheet steel.

- C. Stainless Steel:
  - 1. 1. Manufacturer's standard grade.
  - 2. 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

### 2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

#### 2.6 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

# PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting, otherwise furnish temporary, lensed luminaires for the required task and environment. When construction is sufficiently complete, clean permanent luminaires used for temporary lighting.

#### 3.3 INSTALLATION

A. Comply with NECA 1.

- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install luminaires with diodes and drivers preinstalled at the factory in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and replacing of diode boards.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
  - 1. Secured to outlet box.
  - 2. Attached to ceiling structural members at four points equally spaced around the perimeter of luminaire.
  - 3. Trim ring flush with finished surface with no visible light leaks or ceiling rough edges.
- F. Wall-Mounted Luminaires:
  - 1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
  - 2. Do not attach luminaires directly to gypsum board even for temporary installations.
- G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- 3.4 IDENTIFICATION
  - A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 3.5 FIELD QUALITY CONTROL
  - A. Perform the following tests and inspections:
    - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
    - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
  - B. Luminaire will be considered defective if it does not pass operation tests and inspections.
  - C. Prepare test and inspection reports.

#### 3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

- 1. During adjustment visits, inspect all luminaires. Replace Diodes, drivers, controls or luminaires that are defective.
- 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION

# SECTION 28 31 11

# DIGITAL. ADDRESSABLE FIRE-ALARM SYSTEM

#### PART 1 – GENERAL

#### 11 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- Α. Section Includes:
  - New Fire alarm panel and all components to be SIEMANS. Compatible 1. and networkable with the existing site system.
  - 2. System smoke detectors
  - Heat detectors 3.
  - 4. Notification appliances
  - Device guards 5.
  - 6. Magnetic door holders
  - 7. Addressable interface device
- B. **Related Requirements:** 
  - 1. Division 01, Division 22, Division 23 and Division 26

#### 1.3 DEFINITIONS

- Α. EMT: Electrical Metallic Tubing
- FACP: Fire Alarm Control Panel B.
- C. HLI: High Level Interface
- D. NICET: National Institute for Certification in Engineering Technologies
- E. PC: Personal computer
- F. VESDA: Very Early Smoke-Detection Apparatus

#### 1.4 ACTION SUBMITTALS

- Product Data: For each type of product, including furnished options and Α. accessories.
  - Include construction details, material descriptions, dimensions, profiles, 1. and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- Β. Shop Drawings: For fire-alarm system

- 1. Provide full size drawings to match the construction documents, scale and paper size. Reduced scale is not acceptable.
- 2. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in the California Electrical Code
- 3. Include plans, elevations, sections, details, and attachments to other work.
- 4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
- 5. Detail assembly and support requirements.
- 6. Include voltage drop calculations for notification-appliance circuits.
- 7. Include battery-size calculations.
- 8. Include input/output matrix.
- 9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
- 10. Include performance parameters and installation details for each detector.
- 11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
- 12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
- 13. Include plans, sections, and elevations of heating, ventilating, and airconditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
  - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
  - b. Show field wiring required for HVAC unit shutdown on alarm.
  - c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
  - d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
  - e. Locate detectors according to manufacturer's written recommendations.
  - f. Show air-sampling detector pipe routing.
- 14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- 15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
  - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
  - 2. Shop Drawings shall be prepared by persons with the following qualifications:

- a. Trained and certified by manufacturer in fire-alarm system design.
- b. NICET-certified, fire-alarm technician; Level III minimum.
- c. Licensed or certified by authorities having jurisdiction.
- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
  - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
  - 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
    - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at

every junction point with indication of origination and termination points.

- d. Riser diagram.
- e. Device addresses.
- f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
- g. Record copy of site-specific software.
- h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
  - 1) Equipment tested.
  - 2) Frequency of testing of installed components.
  - 3) Frequency of inspection of installed components.
  - 4) Requirements and recommendations related to results of maintenance.
  - 5) Manufacturer's user training manuals.
- i. Manufacturer's required maintenance related to system warranty requirements.
- j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.

#### 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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
  - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
  - 3. Smoke Detectors, Fire Detectors. Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
  - 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
  - 5. Keys and Tools: One extra set for access to locked or tamper proofed components.
  - 6. Audible and Visual Notification Appliances: One of each type installed.
  - 7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
  - 8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
  - 9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

# 1.9 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Provide network connectivity to existing system at the ASH. Via fiber optic cable or copper hardwired connection in conduit.
- C. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
- D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

# 1.10 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

# 1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

- 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
- 2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 – PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system Coordinate with Atascadero State Hospital. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electrical Code, by a qualified testing agency, and marked for intended location and application.

#### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices
  - 1. Fire Alarm control Panel
  - 2. Fire alarm power supplies and or transponder
  - 3. Communicators
  - 4. Heat detectors.
  - 5. Smoke detectors.
  - 6. Duct smoke detectors.
  - 7. Automatic sprinkler system water flow.
  - 8. Fire-extinguishing system operation.
  - 9. Dry system pressure flow switch
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
  - 2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Unlock electric door locks in designated egress paths.
  - 5. Release fire and smoke doors held open by magnetic door holders.
  - 6. Activate voice/alarm communication system.
  - 7. Switch heating, ventilating, and air-conditioning equipment controls to firealarm mode.
  - 8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.

- 9. Activate stairwell and elevator-shaft pressurization systems.
- 10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
- 11. Activate preaction system.
- 12. Recall elevators to primary or alternate recall floors.
- 13. Activate elevator power shunt trip.
- 14. Activate emergency lighting control.
- 15. Activate emergency shutoffs for gas and fuel supplies.
- 16. Record events in the system memory.
- 17. Record events by the system printer.
- 18. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
  - 1. Valve supervisory switch.
  - 2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
  - 3. Alert and Action signals of air-sampling detector system.
  - 4. Elevator shunt-trip supervision.
  - 5. Fire pump running.
  - 6. Fire-pump loss of power.
  - 7. Fire-pump power phase reversal.
  - 8. Independent fire-detection and -suppression systems.
  - 9. User disabling of zones or individual devices.
  - 10. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.
  - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  - 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
  - 4. Loss of primary power at fire-alarm control unit.
  - 5. Ground or a single break in internal circuits of fire-alarm control unit.
  - 6. Abnormal ac voltage at fire-alarm control unit.
  - 7. Break in standby battery circuitry.
  - 8. Failure of battery charging.
  - 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
  - 10. Voice signal amplifier failure.
  - 11. Hose cabinet door open.
- E. System Supervisory Signal Actions:
  - 1. Initiate notification appliances.
  - 2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
  - 3. Record the event on system printer.
  - 4. After a time delay of 200 seconds transmit a trouble or supervisory signal to the remote alarm receiving station.
  - 5. Transmit system status to building management system.

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

6. Display system status on graphic annunciator.

# 2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 2.4 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall be four-wire type.
  - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
  - 7. Remote Control: Unless otherwise indicated, detectors shall be digitaladdressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    - b. Fixed-temperature sensing characteristic of combination smokeand heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
    - c. Multiple levels of detection sensitivity for each sensor.
    - d. Sensitivity levels based on time of day.
- B. Photoelectric Smoke Detectors:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.

- e. Sensor range (normal, dirty, etc.)
- C. Ionization Smoke Detector:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.)
- D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.)
  - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
  - 4. Each sensor shall have multiple levels of detection sensitivity.
  - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
  - 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

# 2.5 MULTICRITERIA DETECTORS

- A. Mounting: Adapter plate for outlet box mounting.
- B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
- D. Test button tests all sensors in the detector.

- E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - 1. Primary status.
  - 2. Device type.
  - 3. Present sensitivity selected.
  - 4. Sensor range (normal, dirty, etc.)
- F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.
  - 1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
  - 2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
  - 3. Heat sensor shall be as described in "Heat Detectors" Article.
  - 4. Each sensor shall be separately listed according to requirements for its detector type.
- G. Single-Station Duct Smoke Detectors:
  - 1. Comply with UL 268A; operating at 120-V ac.
  - 2. Sensor: LED or infrared light source with matching silicon-cell receiver.
    - a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.
  - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
    - a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
  - 4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
  - 5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

# 2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521
  - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
  - 1. Mounting: Adapter plate for outlet box mounting
- 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
  - 1. Mounting: Adapter plate for outlet box mounting.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Continuous Linear Heat-Detector System:
  - Detector Cable: Rated detection temperature 155 deg F (68 deg C). Listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.
  - 2. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
  - 3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
  - 4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

# 2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notificationappliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- F. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.

The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

- 1. Rated Light Output:
  - a. 15/30/75/110 cd, selectable in the field.
- 2. Mounting: Wall mounted unless otherwise indicated.
- 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
- 4. Flashing shall be in a temporal pattern, synchronized with other units.
- 5. Strobe Leads: Factory connected to screw terminals.
- 6. Mounting Faceplate: Factory finished, red.
- G. Voice/Tone Notification Appliances:
  - 1. Comply with UL 1480.
  - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
  - 3. High-Range Units: Rated 2 to 15 W.
  - 4. Low-Range Units: Rated 1 to 2 W.
  - 5. Mounting: Flush
  - 6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
- H. Exit Marking Audible Notification Appliance:
  - 1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
  - 2. Provide exit marking audible notification appliances at the entrance to all building exits.
  - 3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

# 2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  - 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
  - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  - 3. Rating: 24-V ac or dc.
  - 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.
- C. If needed, none anticipated under this scope.
- 2.9 ADDRESSABLE INTERFACE DEVICE
  - A. General:

- 1. Include address-setting means on the module.
- 2. Store an internal identifying code for control panel use to identify the module type.
- 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarminitiating devices for wired applications with normally open contacts.
- C. Control Module:
  - 1. Operate notification devices.
  - 2. Operate solenoids for use in sprinkler service.
- D. to central station and to ASH central location.

## PART 3 – EXECUTION

- 3.1 EXAMINATION
  - A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
    - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.
  - B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
  - C. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in the California Electrical Code including, but not limited to, Article 760, "Fire Alarm Systems."
  - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
  - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
  - 1. Connect new equipment to existing control panel in existing part of the building.
  - 2. Connect new equipment to existing monitoring equipment at the supervising station.

3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

- C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Smoke- or Heat-Detector Spacing:
  - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
  - 3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
  - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
  - 5. HVAC: Locate detectors not closer than 36 inches ((910 mm)) from airsupply diffuser or return-air opening.
  - 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
  - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

# 3.3 PATHWAYS

- A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
  - 1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.
- B. Pathways shall be installed in metal conduit, minimum size 3/4".
- C. Exposed EMT shall be painted red enamel.

## 3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are listed for use with installed firealarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
  - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
  - 3. Smoke dampers in air ducts of designated HVAC duct systems.
  - 4. Magnetically held-open doors.
  - 5. Electronically locked doors and access gates.
  - 6. Alarm-initiating connection to elevator recall system and components.
  - 7. Alarm-initiating connection to activate emergency lighting control.
  - 8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  - 9. Supervisory connections at valve supervisory switches.
  - 10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
  - 11. Supervisory connections at elevator shunt-trip breaker.
  - 12. Data communication circuits for connection to building management system.
  - 13. Data communication circuits for connection to mass notification system.
  - 14. Supervisory connections at fire-extinguisher locations.
  - 15. Supervisory connections at fire-pump power failure including a deadphase or phase-reversal condition.
  - 16. Supervisory connections at fire-pump engine control panel.

# 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

# 3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

# 3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

# 3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

# 3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

# SECTION 31 00 00

# EARTHWORK

# PART 1 GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Excavation (cut)
  - 2. Embankment (fill)
  - 3. Clearing and Grubbing
  - 4. Subgrade Preparation
- B. Excavation includes excavating all materials, of whatever character and subsurface conditions, as required for the construction of the project, including but not limited to the following:
  - 1. Excavation for roadways
  - 2. Excavation for the construction of pavement and hardscape areas
  - 3. Excavation for structure foundations
  - 4. Excavation for mass grading
  - 5. Excavation for finish grading
  - 6. Overexcavation of areas to be recompacted
- C. Embankment (fill) includes the construction of embankments and placing of material, including the following:
  - 1. Embankment for Roadways
  - 2. Embankment for the construction of pavement, and hardscape areas
  - 3. Backfilling of structures
  - 4. Embankment for Mass Grading
  - 5. Embankment for Finish Grading
  - 6. The placement of native, select and other backfills
- D. Clearing and grubbing includes the removal of all objectionable materials with the area to be graded. Earthwork shall include all clearing and grubbing.
- E. Whenever the term finished grade is used, it shall mean the finished surface of the completed facility.

## 1.02 SUBMITTALS

- A. Delivery certifications (load slips) for all aggregate base supplied.
- B. Delivery certifications (load slips) for all imported fill and backfill.
- C. Delivery certifications (load slips) for concrete slurry backfill.
- D. Furnish, without additional cost to the Owner, such quantities of import or native materials as may be required by the Engineer for test purposes.

# PART 2 PRODUCTS

## 2.01 MATERIALS

- A. No materials shall be delivered to the site that are not in conformance with these specifications, or unless accepted by the engineer in writing.
- B. Select Backfill: Backfill designated as "select", or "sand" shall conform to be the Caltrans Standard Specifications, Paragraph 19-3.025B for Sand Bedding.
- C. Cement Slurry Backfill: Cement Slurry backfill shall be 1-sack mix sand-cement slurry, and shall conform to the material requirements described in Caltrans Standard Specifications, Section 19-3.062.
- D. Native Material: The Soils Engineering Report identifies the on-site soil materials. Native materials excavated from site area may be used as general fill, with the approval of the Soils Engineer. Such native soils shall not be used for pipe bedding or pipe zone backfill. Borrow material used for soil surcharging, if approved by the Soils Engineer, and meets requirements for backfill, may be used for fill.
- E. Fill:
  - 1. Onsite materials: The on-site materials generally consist of artificial fill, consisting of medium stiff to very stiff gravelly lean clay with sand. Monterey shale was encountered below the artificial fill at depths of approximately 1.5 feet in on-site borings at the time of the soils investigation. Fill material shall not contain rocks over 3-inches.
  - 2. Imported materials: Imported non-expansive material to be used as fill shall be clean soil free of rocks, debris, contamination, or other objectionable material.
- F. Imported Nonexpansive Material: Imported nonexpansive material shall be coarse grained (ASTM D 2488-00) and shall have an expansion index of less than 10 (ASTM D 4829-03). Nonexpansive materials proposed for import shall be approved by the Engineer prior to being transported to the site, and shall be subject to further sampling and/or review during construction.
- G. Crushed Gravel: Crushed gravel shall be free draining crushed rock conforming to ASTM C33 #67 stone. Float Rock or river run gravel is not acceptable.
- H. Class 2 Base: 3/4" minus, per Caltrans Section 26, Para. 1.02.B.

## 2.02 DEFINITIONS

- A. Compaction: Maximum dry density as defined by ASTM D 1557-07.
- B. Field density: ASTM D 2922-01
- C. Subgrade: The grading plan below an aggregate base or sand layer.

# PART 3 EXECUTION

## 3.01 EARTHWORK MAINTENANCE

- A. The Contractor shall be responsible for all maintenance related to the earthwork operations, both on and offsite. The contractor shall maintain all areas clean of dust, mud and debris, and shall control erosion during the earthwork operations
- B. Street Cleaning: The Contractor shall exercise care in the use of public and private roads and shall repair at his own expense any damage thereto caused by his operations. Such repair shall be to the satisfaction of the owner or agency having jurisdiction over the road. The Contractor shall take whatever means are necessary to prevent tracking of mud onto existing roads and shall keep roads free of debris. The Contractor shall utilize street cleaning machines as necessary to maintain the streets free of dirt and debris from its operations at all times.
- C. Dust Control: Take proper and efficient steps to control dust. Contractor to supply water for dust control.
- D. Storage of Materials: Neatly place excavated materials far enough from the excavation to prevent stability problems. Keep the materials shaped so as to cause the least possible interference with drainage. Provide all such erosion control measure as are required to prevent loss of material or damage to property. The cost of maintaining and protecting stockpiled materials shall be considered to be included in the price paid for excavating, filling, or furnishing the materials, and there will be no separate payment allowed therefore.
- E. Existing Facilities: Maintain access to existing facilities to permit continued operation as required by the Owner.
- F. Finished Condition: Grades shall be maintained in a finished condition and true to grade until acceptance of the contract as complete.

#### 3.02 CLEARING AND GRUBBING

- A. Unless shown otherwise on the drawings, the entire area to be graded shall be cleared and grubbed.
- B. The natural ground surface shall be cleared of all vegetation including trees, logs, upturned roots, roots of down trees, brush, grass, weeds and other objectionable material including concrete and masonry.
- C. Within the limits of clearing, the areas below the natural ground surface, shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material.
- D. Voids created by the above removals shall be filled and recompacted with the material and to the requirements of the area in question.
- E. Properly dispose of all removed objectionable material.

# 3.03 EXCAVATION

- A. The Contractor shall perform all construction excavation, including hand digging, shoring, de-watering, asphaltic concrete removal, concrete removal, and grading necessary or required for the construction of the Work as covered by these Specifications and indicated on the Drawings. The excavation shall include, without classification, the removal and disposal of all materials of whatever nature encountered, including water and all other obstructions that would interfere with the proper construction and completion of the required work.
- B. Temporary Excavation Slopes: Temporary exaction slopes shall comply with OSHA requirements for the soil types and conditions encountered. Unless other materials are encountered, temporary excavation slopes shall be constructed as follows:
- C. Barriers: Barriers shall be placed around all excavations and at such places as may be necessary to warn all pedestrian and vehicular traffic of such excavations.
- D. Sawcutting Pavement: Where trenching or excavation occurs in paved areas to remain, the pavement shall be saw-cut and broken ahead of the trenching or excavation operation. The extent of paving removed shall be limited to the minimum necessary for the excavation. However, the sawcut limits shall be extended for the following reasons:
  - 1. To form neat, straight and square lines.
  - 2. To include areas of pavement damaged by the Contractor.
- E. 2:1 Slopes: Finished cut slopes shall not exceed the steepness shown on the plans. If no steepness is designated, the maximum slope shall be 2 horizontal to 1 vertical.

# 3.04 EMBANKMENT (FILL)

- A. The Contractor shall perform all construction embankment and filling including shoring, de-watering, backfilling, structural fill, non structural fill, sand and aggregate bases, compaction and grading necessary or required for the construction of the Work as covered by these Specifications and indicated on the Drawings. Embankment (fill), shall include, without classification, the preparation, placement, compaction and finishing of all earth materials to the lines and grades prescribed by the Contract Documents.
- B. Scarification: Areas to receive fill shall be prepared by clearing and grubbing, and scarifying to a minimum depth of 12 inches, moisture conditioning and recompacting to the minimum relative compaction specified for the fill to be placed above.
  - 1. Voids created by dislodging cobbles and/or debris during scarification shall be backfilled and recompacted, and the dislodged materials shall be removed from the work area.
  - 2. Obtain approval from the Engineer prior to placing fill on a prepared foundation.
- C. General fill and backfill soils shall be placed in level lifts not exceeding 8 inches in loose thickness, moisture conditioned, and compacted. All materials used as

fill shall be cleaned of all debris and any rocks larger than 3 inches in diameter. When fill material contains rocks, the rocks shall be placed in a sufficient soils matrix to ensure that voids caused by nesting of the rocks will not occur and that the fill can be properly compacted.

- D. Moisture Content: At the time of compaction, the moisture content of fill materials shall be such that the specified relative compaction will be obtained and the fill will be in a firm and stable condition. Fill material which contains excessive moisture shall not be compacted until the material is dry enough to obtain the required compaction. Full compensation for any additional work involved in drying fill material to the required moisture content shall be considered included in the contract price paid for excavating or furnishing the material and no additional compensation will be allowed therefore.
- E. Compaction: Fill shall be placed and compacted as indicated on the plans or specifications. If no compaction level is specified, the following shall be used as the minimum relative compaction.

1.	Upper 36 inches of subgrade	95%
2.	All aggregate Bases	95%
3.	Other fill areas:	90%
4.	Trench Backfill: Per Section 31 23 33 Trenching and backfill	
5.	Select Backfill	95%
6.	Tank and foundation areas within 5 feet horizontal of footprint	95%
7.	Un-paved dirt areas, upper 12 inches of native material	85%

F. 2:1 Slopes: Finished fill slopes shall not exceed the steepness shown on the plans. If no steepness is designated, the maximum slope shall be 2 horizontal to 1 vertical.

# 3.05 PAVEMENT SUBGRADE PREPARATION

- A. Pavement subgrade preparation shall be in accordance with Section 26-1.03 of the Caltrans Standard Specifications, except as specified herein. Sub-grade preparation shall include excavation and backfill to subgrade and all related removal of existing facilities and materials. Existing native materials shall be removed and disposed of to the depth necessary to achieve a prepared and compacted sub-grade.
- B. Subgrade shall be scarified to a minimum depth of 24 inches below ground surface or 12 inches below structural section, whichever is deeper. The soil shall then be moisture conditioned for proper compacting and then compacted to a relative compaction of not less than 95%.
- C. Tolerances: The Subgrade elevation shall not vary more then 0.05 feet above or below the plan specified, except that if the subgrade elevation is more than 0.05 feet below the specified grading plane, the Contractor may place and compact Class 2 aggregate base to raise the surface to within tolerances. There shall be no additional payment for such Class 2 aggregate base.
- D. Proof rolling: Proof roll the subgrade with rubber tired construction equipment in the presence of the Engineer. The subgrade shall be firm and unyielding when proof-rolled.

# 3.06 UNSUITABLE SOIL

- A. Unsuitable soil is soil that due to its nature, cannot be properly compacted to or is yielding and cannot provide support for the overlying structural section.
- B. A condition of soil moisture exceeding optimum moisture content to a degree that causes yielding or prevents proper compaction shall not be cause to consider soil as unsuitable.
- C. The Engineer shall determine whether soil shall be considered unsuitable. If the soil is determined to be unsuitable, the Engineer may direct the Contractor to follow an alternative method of construction to provide additional support. Such alternative measures will be paid for as extra work.

# 3.07 WET SOIL

A. If wet soils are encountered, the Contractor shall take such measures as are required to dry the soil to a degree that it can be compacted and form a firm and unyielding surface. These measures shall be included in the bid items requiring such compaction and there shall be no separate payment therefore.

# 3.08 TESTING

- A. Material Quality: When requested by the Engineer, the Contractor shall provide samples of earthwork materials furnished or excavated in sufficient quantities for materials testing. There shall be no additional payments made for providing such samples. Should any materials fail to meet the Contract requirements, the Contractor shall remove all such nonconforming material, and replace it with conforming material at no cost to the Owner.
- B. Field Testing and Observation:
  - 1. The Contractor shall coordinate his activities to allow for the following inspection by the Owner:
    - a. Review and test materials proposed for use.
    - b. Observe excavations prior to backfilling or pouring concrete.
    - c. Observe placement and test compaction of fill.
  - 2. The Contractor shall excavate holes for in-place soil sampling. The Owner will pay for initial testing. If initial tests fail inspection, the failed portions shall be removed, re-compacted, and re-tested. The Contractor shall be responsible for costs of additional inspection and re-testing resulting from non-compliance.
- C. Testing Methods:
  - 1. Relative Compaction: In-place density divided by the maximum dry density laboratory compaction expressed as percentage.
  - 2. Durability Index: Manual of Test, State of California, Department of Transportation
    - a. R Value Testing: California Test 301
    - b. Specific Gravity: ASTM D854.
    - c. Laboratory Compaction: ASTM D1557, Method A or C
    - d. In-place Density: ASTM D1556 or ASTM D2922
    - e. Particle Size Analysis of Soils: ASTM D422
    - f. Plastic Limit and Plasticity Index: ASTM D4318

- g. Soil Classification: ASTM D2487
- h. In-place Moisture Content: ASTM D3017

## 3.09 CONTROL OF WATER

- A. General: The Contractor shall be responsible for the control of surface drainage and subsurface water throughout the construction project.
- B. Surface Water: The Contractor shall be responsible for furnishing temporary drainage facilities to convey and dispose of surface water falling on or passing over the site.
- C. Subsurface Water: The Contractor is responsible for the control of groundwater during general and trench excavations. See Section 31 23 19, Dewatering. Methods that may be required during construction include over-excavation, pumping, drying soil, and shoring. The Contractor shall include the cost of such measures in the bid items requiring such excavation.
- D. Disposal of water: Dispose of water in such a manner as to cause no injury or nuisance to public or private property or be a menace to the public health. De-watering devices must be adequately filtered to prevent the removal of fines from the soil.
- E. Maintain soil moisture content throughout construction. Do not allow desiccation cracks to occur within the project area. If desiccation cracks are allowed to occur, the soils that have cracked due to desiccation shall be removed, moisture conditioned, and recompacted at the Contractors' expense.

## 3.010 DISPOSAL OF EXCAVATED MATERIAL

- A. Use as trench backfill: Excavated material shall not be used as trench or select backfill, unless it is designated as such in these specifications or if approved in writing by the Engineer. Excavated material may be used as subsequent backfill provided requirements of Paragraph 2.01E of this Section are met. Also refer to Section 31 23 33, Trenching and Backfilling.
- B. Use as onsite fill: Excavated soil may be used as onsite fill, subject to the restrictions in these specifications.
- C. Export: Where excavated material will not be reused onsite, the Contractor shall haul the material away. The Contractor is responsible for determining the nature of the material to be exported, for the proper location to deliver the material to, for obtaining all permits and processing, and for the proper placement and handling of the material at the offsite location.

# SECTION 31 23 33

# TRENCHING AND BACKFILLING

# PART 1 GENERAL

## 1.01 SUMMARY

- A. Section Includes:
  - 1. Trench excavation.
  - 2. Trench Backfill.
  - 3. Control of surface waters and groundwater.
  - 4. Temporary and permanent resurfacing.
  - 5. OSHA Compliance, Sheeting, Shoring and Bracing
- B. SUBMITTALS
  - 1. Delivery certifications (load slips) for all aggregate base and backfill.
  - 2. Delivery certifications (load slips) for concrete slurry backfill.
  - 3. Material samples as may be required by the Engineer for test purposes.

## PART 2 PRODUCTS

- 2.01 Select Backfill: Section 31 00 00 Earthwork
- 2.02 Slurry Cement Backfill: Cement Slurry backfill shall be 1-sack mix sand-cement slurry, and shall conform to the material requirements described in Caltrans Standard Specifications, Section 19-3.062.
- 2.03 Native Material as Trench Backfill: Local on-site native soil materials shall not be used as trench backfill in the pipe zone, unless approved in writing by the Engineer. Native material may be used as subsequent backfill provided requirements of Paragraph 2.01E, Section 31 00 00, are met, and such material is approved for use by the Engineer.
- 2.04 Bedding: Select backfill per Paragraph 2.01B, Section 31 00 00.
- 2.05 Pipe Zone Material: Imported or native non-expansive material per Paragraph 2.01F, Section 31 00 00.

## PART 3 EXECUTION

- 3.01 GENERAL
  - A. Contractor shall install pipeline as closely as possible to alignment and grade indicated on the Drawings, except for minor adjustments to avoid architectural and structural features, make minor adjustments in horizontal and vertical alignment and deflection to tie-in to existing pipelines and to meet general intent of pipeline layout. Minor adjustments to pipeline layout, which may require fittings, couplings, joint deflection or other minor adjustment, are considered Contractor means and methods and are not shown on the drawings. Contractor shall make such minor adjustments as necessary, at no additional cost to Owner.

# 3.02 TRENCH EXCAVATION

- A. Trenches shall be constructed in accordance with the details shown on the Drawings, and the following:
- B. Excavation limits: Excavate trenches to the minimum and maximum trench widths shown on the drawings.
- C. Open Trench Construction: Trench construction shall be by open trench excavation unless shown otherwise on the plans.
- D. Maximum Length of Open Trench: Except by permission of the Engineer, the maximum length of open trench shall be 200 feet, or the length of pipe that can be installed in a single day, whichever is less. The length of open trench includes open excavation, areas with active pipe laying and backfilling, and those areas not yet temporarily resurfaced.
- E. Utility Crossings: Protect all existing facilities to be crossed. Hand digging of trenches may be necessary.
- F. Trench Excavation in Existing Paved Areas to be Restored to Pre-Construction Condition: In paved areas, the trench excavation limits shall be neatly sawcut. The sawcut lines shall be straight and neat in appearance and shall be parallel or perpendicular to the trench construction, unless otherwise allowed by the Engineer. The sawcut limits shall be extended as necessary to include the entire excavation, and any edges damaged during construction.
- G. Trench Excavation in Areas of New Pavement: The trench excavation limits need not be sawcut in areas where new pavement will be installed. All trench excavation and backfilling operations shall be completed prior to final paving.
- H. No sloped wall construction for utilities shall be allowed.
- I. Over-Excavation: If the trench is over excavated below the limits necessary, backfill and compact to 95 percent relative compaction with select backfill. There shall be no additional payment to the Contractor for over-excavations not directed by the Engineer.
- J. Unsuitable Material: Unsuitable soil is soil that due to its nature cannot be properly compacted to or is yielding and cannot provide support for the overlying structural section. Excessive moisture content shall not be cause for a material to be considered unsuitable. The Engineer shall determine whether soil shall be considered unsuitable. If the soil is determined to be unsuitable, the Engineer may direct the Contractor to remove the material and replace it with select backfill or other material as directed by the Engineer. Such alternative measures will be paid for as extra work.
- K. Wet soil: A condition of soil moisture exceeding optimum moisture content to a degree that causes yielding or prevents proper compaction shall not be cause to consider soil as unsuitable. If wet soils are encountered, the Contractor shall take such measures as are required to dry the soil to a degree that it can be compacted and form a firm and unyielding surface. These measures, which may include gravel bedding in lieu of sand bedding, wrapped in filter fabric as directed

by the Soils Engineer, shall be included in the bid items requiring trench construction. There shall be no separate payment therefore.

- L. Trenches in Fill Areas: For trenches to be excavated through fill, including previously placed trench backfill (such as at manholes or for building connections), the structural backfill shall be first compacted at a level at least 3 feet from the top of the piping or conduit elevation and then retrenched to pipe grade.
- M. Disposal: Disposal of excavated material shall be as specified in Section 31 00 00 Earthwork.

## 3.03 PIPE BEDDING AND PIPE ZONE

- A. Unless shown otherwise on the plans, trench bedding shall be defined as that material 6" below the pipe, supporting, surrounding and extending 12" above the top of pipe.
- B. Unless shown otherwise on the plans or specifications, trench bedding and pipe zone material shall be poorly or well graded granular sandy material (SW or SP) compacted to 90 percent, and meeting a sand equivalent of 30 or greater. Such material shall be free of organics, corrosives, clay, recycled materials, and other deleterious substances.
- C. Bedding Placement: Sand bedding shall be placed to provide uniform support for the pipe or conduit prior to lowering the pipe or conduit in place. Holes shall be shaped for pipe bells, and the bedding shall be rounded to the shape of the pipe barrel. If the bedding exceeds 6 inches below the bottom of the pipe, it shall be compacted to a relative compaction of 95% prior to placing the pipe. Bedding shall be completed and compacted prior to placing any pipe zone backfill.
- D. Cement Slurry Bedding Placement: Prior to placing cement slurry bedding, the Contractor shall employ a method to prevent the pipe from floating or shifting position. If the pipe or conduit does float or shift position, the contractor shall be responsible for removing and reinstalling the pipe or conduit. Plugs and/or barriers shall be used to prevent the cement slurry from flowing to unwanted areas of the trench or into the pipe.
- E. After placing cement slurry bedding, subsequent backfill may not be placed for 8 hours unless the subsequent backfill is also cement slurry, except that if the when concrete sand is used for the aggregate and the in-place material is free draining, backfilling may commence as soon as the surface water is gone.

# 3.04 TRENCH BACKFILL

- A. Inspection Prior to Backfill: Backfill material shall not be placed over the pipe or conduit until after the joints have been completed and inspected by the Engineer.
- B. Protect pipes from flotation during backfill and compaction.
- C. Backfill in existing paved areas where the depth of cover will be 2 feet or less shall be cement slurry. For HDPE pipe, cement slurry backfill shall be used in existing streets, if the depth of cover is less than 3 feet.

- D. Placement of Trench Backfill: Trench Backfill shall be placed in level lifts not exceeding 6 inches in loose thickness, moisture conditioned, and mechanically compacted.
- E. The minimum compaction (percent of maximum dry density) shall be:
  - 1. 90 percent for general trench compaction in pipe bedding, pipe zone and subsequent backfill.
  - 2. In paved areas, 95 percent in the top 12-inches below subgrade.
  - 3. In non-paved areas, 85 percent in the top 12 inches below finished surface, with the upper 12 inches being native soils.
  - 4. In paved plant areas, the upper 36-inches below finished surface shall be compacted to 95 percent.
- F. Compaction of backfill by jetting or flooding shall not be allowed.
- G. No Trenches Left Open: All trenches shall be backfilled to the surface as soon as possible after the installation of the facilities. Prior to stopping work each day, all open trenches shall be backfilled to the surface or protected with non-skid traffic-rated steel plates.
- H. If steel plates are used, they shall comply with the Caltrans Construction Manual.

# 3.05 TRENCH RESURFACING

- A. Surface Restoration: Unless another surface is shown on the plans or specifications, the surface shall be restored to the materials that existed prior to trenching.
- B. Temporary Paving: Prior to final paving, trenches in paved areas shall be surfaced with cold mix. Cold mix shall be a minimum of 3 inches thick. The Contractor shall maintain the cold mix in a smooth condition flush with the adjacent pavement throughout the time that it is in place.
- C. Steel Traffic Plates: When approved by the Engineer, steel traffic plates may be used in lieu of backfilling and temporary paving. Steel plates shall be skid-resistant and placed in accordance with Caltrans Standards. Cold mix shall be used to provide smooth transition around the traffic plates. The Contractor shall monitor the condition of the traffic plates and maintain their placement to provide a safe driving condition.

# 3.06 TESTING

- A. Compaction Testing: The Owner will hire an independent testing company to perform compaction testing. The Contractor shall make the trench available to the tester, at the depths and locations required by the Engineer. When testing requires personnel to enter into a deep trench, the Contractor shall provide all shoring or other methods necessary for a safe working condition in compliance with the approved trench safety plan, The cost of providing safe access to the trench backfill for testing purposes shall be included in the bid items requiring such trench backfill, and there will be no separate payment therefore.
- B. Failed Compaction Tests: The Owner will pay for the initial cost of compaction tests. Should any initial or subsequent test indicate that the material fails to meet the required level of compaction, the Contractor shall be responsible for all such

measures necessary to bring the material into compliance, at no additional cost to the Owner. The backfill shall then be retested. The Contractor is responsible for the cost of such retesting following a failed test, and the Owner may deduct the cost of such from the amounts owed under the Contract.

#### 3.07 OSHA COMPLIANCE

- A. Excavation Safety: The Contractor's attention is directed to the provisions in Sections 6705, and 6707 of the State Labor Code, California Civil Code Section 832, the United States Department of Labor Rules 29 CFR, Part 1926, the Cal-OSHA Construction Safety Orders, Section 5.47, Safety and Trenching of these Specifications.
- B. Trench Safety Plan: Prior to performing excavation for any trench over five feet in depth, the Contractor shall submit for approval by the Engineer, a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of trenches. If such plan complies with the Construction Safety Orders, it shall be submitted at least 5 working days prior to the start of trench excavation. If such plan varies from the Cal-OSHA Construction Safety Orders, the plan shall be prepared and signed by a registered Civil Engineer, and shall be submitted at least 4 weeks prior to any trench excavation. No trenching shall begin until such plan has been approved by the City.
- C. Permit: The Contractor shall have a Cal-OSHA permit as required by California Labor Code Section 6500. Prior to beginning any excavation, the Contractor shall submit a copy of the Cal-OSHA permit and shall identify in writing the Competent Person designated to be in charge of trench safety for this project.
- D. Submittals: The Contractor shall provide the following submittals:
  - 1. Cal-OSHA compliance: Nothing in this section shall be deemed to allow the use of a shoring, sloping, or protective system less effective than that required by the construction safety orders. Failure to comply with any of the Cal-OSHA rules, orders, and regulations shall be sufficient cause for the Engineer to immediately suspend all work. No compensation for costs incurred by such emergency suspension will be allowed.
  - 2. Designation of the Competent Person for trench safety as defined by OSHA.
- E. Adjacent Improvements: Provide support for excavations adjacent to existing improvements and structures to prevent damage or settlement. Attention is directed to the Soils Engineering Report and to Section 832 of the Civil Code of the State of California relating to lateral and subjacent supports.
- F. Removal of trench supports: The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting, and bracing shall be carefully removed so there shall be no voids created and no caving, lateral movement, or flowing of the subsoil.

# SECTION 32 12 00

# FLEXIBLE PAVING (HOT MIX ASPHALT)

# PART 1 GENERAL

## 1.01 SUMMARY

- A. Section Includes:
  - 1. Flexible paving, hot mix asphalt (HMA)
  - 2. Aggregate subbase course
  - 3. Pavement marking
- B. In accordance with Caltrans 2018 Standard Specifications, except as noted herein.
- 1.02 SUBMITTALS
  - A. Caltrans Section 39-2.01A(3) does not apply. Comply with the following:
    - 1. HMA Mix Design demonstrating compliance with mix design requirements specified herein.
    - 2. Class 2 base shall conform to the provisions of the Caltrans Section 26. No additional testing, other than that specified (Gradation Limits, R-Value, Sand Equivalent and Durability Index), shall be required.
    - 3. Delivery certifications (load slips) indicating the specification and tonnage for all HMA delivered to the site.
    - 4. Delivery certifications (load slips) indicating the specification and tonnage for all base materials delivered to the site.
    - 5. Pavement Marking submittal per Caltrans Section 84-2.01C.

## PART 2 PRODUCTS

- 2.01 NO MATERIALS SHALL BE DELIVERED TO THE SITE THAT ARE NOT IN CONFORMANCE WITH THESE SPECIFICATIONS, OR UNLESS ACCEPTED BY THE ENGINEER IN WRITING.
  - A. Caltrans Section 39, do not use Revised Standard Specification (RSS).
  - B. Method process per Caltrans Section 39.
  - C. Hot mix asphalt, Type A, <sup>1</sup>/<sub>2</sub>-inch
  - D. Asphalt binder, PG64-10.
  - E. Provide tack coat per Caltrans Section 39.
  - F. Class 2 aggregate base per Caltrans Section 26-1.02B, 3/4 inch aggregate size.
  - G. Pavement markings per Caltrans Section 84, thermoplastic.

# PART 3 EXECUTION

# 3.01 GENERAL

A. In accordance with applicable Caltrans Sections 26 and 39.

# SECTION 32 16 00

# CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

# PART 1 GENERAL

## 1.1 DESCRIPTION

- A. The work shall include furnishing and placing all materials and labor and equipment to construct cast in place concrete, including concrete, reinforcement, formwork, finishing and appurtenances.
- B. Except as specified herein, all concrete work shall be performed in accordance with the applicable sections of the Caltrans 2018 Standard Specifications.

## 1.2 STANDARDS

- A. Caltrans Section 52 Reinforcement
- B. Caltrans Section 73 Concrete Curbs and Sidewalks
- C. Caltrans Section 90 Concrete

## 1.3 SUBMITTALS

A. Delivery Certifications (Load Slips) for all concrete supplied.

## PART 2 PRODUCTS

# 2.1 GENERAL

A. Unless specified otherwise all products used for cast in place concrete shall conform to the Caltrans material specifications.

## 2.2 CONCRETE CLASSIFICATIONS

A. Unless otherwise specified, concrete used on the project for flatwork, concrete collars for utilities, concrete thrust blocks, concrete pads, shall be considered minor concrete, and of Type II cement and mineral admixture, and shall have a minimum compressive strength of 2,500 psi.

## PART 3 EXECUTION

## 3.1 GENERAL

A. Unless specified otherwise, execution of work for cast in place concrete shall conform to the Caltrans Standard Specifications.

# SECTION 32 31 13

# CHAIN LINK FENCES AND GATES

# PART 1 – GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Chain link fences, gates, grade beams, accessories, and hardware
  - B. Related Sections:
    - 1. Section 02 41 19 Selective Demolition
    - 2. Section 03 30 00 Cast-In-Place Concrete
    - 3. Section 09 96 00 High Performance Coatings

## 1.2 REFERENCES

- A. ASTM A121 Metallic-Coated Carbon Steel Barbed Wire
- B. ASTM A123 Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
- C. ASTM A153 Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
- D. ASTM A392 Zinc Coated Steel Chain Link Fence Fabric
- E. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- F. ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- G. ASTM A817 Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire
- H. ASTM A824 Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence
- I. ASTM F1083 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded for Fence Structures
- J. AISI 430 Stainless Steel
- K. California Department of Transportation (Caltrans) Standard Specifications
- L. SSPC The Society for Protective Coatings

# 1.3 SUBMITTALS

- A. Submit under provisions of Sections 01 33 00 and 01 33 23.
- B. Shop drawings: Indicate plan layout, spacing of components, post and grade beam details and dimensions, details of post installation and bracing, hardware anchorage, schedule of components, and hardware schedule.
  - 1. Shop drawings, material, fabrication and installation specifications must be based on hardware templates submitted to the gate fabricator by the lock manufacturer.
  - 2. Indicate surface applied steel frames or shapes necessary for the installation of locks. Show type and spacing of anchorage. Indicate permissible tolerances for each type. Indicate type, size and spacing of field welding required for each item.
- C. Product Data: Provide manufacturer's technical data and specifications for products to be installed.
- D. Samples:
  - 1. Submit samples of material to verify matching of existing materials on site.
- E. Certificate of Compliance: Prior to incorporation in construction, submit manufacturer's certificate that specific products proposed for use meet or exceed specified requirements.
- F. Test Reports: Submit results of specified tests indicating compliance with specified requirements.
- G. Warranty: Sample of special warranty

# 1.4 QUALITY ASSURANCE

- A. The Owner will employ and pay for the services of an independent testing laboratory to perform specified testing per CCR Title 24, and any other testing specifically indicated in the Contract Documents to be performed by Ownerretained testing laboratory, to verify compliance with the Contract Documents.
- B. Like items of materials must be the end products of one manufacturer.

## 1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience.

## 1.6 MOCK-UPS

A. Not Required for this project.

# 1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to submitting shop drawing for review. All reference dimensions shall be clearly indicated on the shop drawings.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packaging:
  - 1. Final gate assemblies must be wrapped in protective material or crated to provide adequate protection during shipment.
  - 2. Units must be appropriately marked with plan gate numbers, size, handing, and hardware type.

# 1.9 PROJECT CONDITIONS

A. Do not install security fence until clearing and finish grading on both sides of the intended fence location is approved.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which both Manufacturer and Installer jointly agree to repair or replace, at no charge, components of chain-link fences, barbed tape, gates, gate operators and hardware, and coatings that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deflection of fence fabric beyond design limits.
    - b. Faulty operation of gate hardware, operators and controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five years from date of Project completion.

## PART 2 – PRODUCTS

## 2.1 MATERIALS

- A. Framework:
  - 1. Unless specified otherwise, framework must be Type I pipe or Type II pipe at Contractor's option.
  - 2. Type I Pipe:
    - a. ASTM F1083 standard weight (Schedule 40), plain ends
  - 3. Type II Pipe:

- a. ASTM A1011, or ASTM A653, Grade D; cold formed, electric welded; minimum yield strength 50,000 psi
- b. Coating must conform to ASTM A123 or Section 80-4.01 A paragraphs 3 and 4 of the Caltrans Specifications, except the reference to 300 hours in paragraph 3 must be 650 hours, and reference to the Engineer in paragraph 4 must be the Owner Representative.
- 4. Dimensions and Weights:

Outside Diameter	Type I Steel	Type II Steel
(OD) in inches	Weight/Foot	Weight/Foot
2.375	3.65	3.12
2.875	5.79	4.64
4.000	9.11	6.56
6.625	17.97	Not Permitted
8.625	28.55	Not Permitted

- 5. Terminal Posts (End, Corner, and Angle Posts):
  - a. Minimum 4.000-inch OD at fences with fabric extending 12 feet or less above finish grade.
  - b. Minimum 6.625-inch OD elsewhere.
- 6. Line Posts:
  - a. Minimum 2.875-inch OD at fences with fabric extending 12 feet or less above finish grade.
  - b. Minimum 4.000-inch OD elsewhere.
- 7. Gate Posts: Type I Pipe; minimum 4.000-inch OD where gate leaf width is 6 feet or less and fabric height of fence and gate leaf extends 12 feet or less above finish grade; minimum 6.625-inch OD elsewhere.
- 8. Rails (Intermediate and Bottom) and Braces: 2.375-inch OD.
- 9. Tension Wire: ASTM A824; Type II, Class 3.
- B. Fabric:
  - 1. Standard:
    - a. ASTM A392; Class 2 zinc coating
    - b. Two inch diamond mesh, No. 9-gauge wire
    - c. Knuckled bottom selvage; twisted and barbed top selvage except knuckled top selvage where indicated
  - 2. No Climb Fence Fabric:

- a. Wire Diameter: 0.192-inch
- b. Mesh Size: 3/8-inch
- c. Weight of Metallic (Zinc) Coating: ASTM A392, Type II, Class 2, 2.0 oz/sq. foot with zinc coating
- C. Barbed Wire: ASTM A121; 12.5-gauge; 14-gauge four point round barbs, 5-inch spacing; class 3 coating.
- D. Barbed Tape:
  - 1. AISI 430 stainless steel hardened to Rockwell (30N) 30-37 minimum; 0.025-inch thick x 1-inch wide before fabrication, die stamped to produce clusters of four needle-sharp barbs at 4 inches on center, minimum 1.2 inches long, offset in alternate directions 0.15 to 0.45 inches.
  - 2. Permanently cold clench stainless steel strip to minimum 230 degree wrap over 300 series austenitic stainless steel spring type reinforcing wire, 0.098-inch diameter, and minimum 140,000 psi tensile strength.
  - 3. The stainless steel strip between barb clusters must be 1/4 inch wide minimum after cold clenching to create a flange extending out from the wire, tapering off adjacent to the barb cluster to allow maximum barb penetration.
  - 4. Coil Diameter: 30 inches, plus or minus two inches, when coil compressed.
  - 5. Each coil must have 51 loops and cover 25 feet maximum when fully extended.
  - 6. Adjacent coils and individual loops in each coil must be clipped together in five locations along the circumference to obtain a concertina effect.
  - 7. Clips: Stainless steel, capable of withstanding a minimum pull load of 200 pounds for a minimum of 30 seconds without separation, or other damage.
- E. Bottom Rail Anchors: No. 3 reinforcing bars, U-shape with hooks on each end.
- F. Concrete:
  - 1. Unless otherwise indicated, provide concrete complying with Type C Concrete per section 03 30 00.
- 2.2 ACCESSORIES
  - A. Fittings:
    - 1. Malleable steel, cast iron, or pressed steel

- 2. Fittings include extension arms for barbed wire, tension bars and bands, clips, truss rod assemblies, boulevard clamps, brace bands, rail ends, hardware, fabric and barbed tape fastenings and accessories.
- B. Tension (Stretcher) Bars: One piece lengths equal to full height of fabric with a minimum cross section of 1/4-inch by 3/4-inch.
  - 1. Provide one tension bar for each gate post and end post
  - 2. Provide two tension bars for each corner post
- C. Tension (Stretcher) Bar Bands: Steel, 3/4-inch x 1/10-inch nominal to secure tension bars to posts.
- D. Extension Arms:
  - 1. 18 inches long, 45 degree bracket type; slits at even spacing for three strands of barbed wire.
  - 2. Extension arms must permit permanent attachment to post without welding. Provide mechanical attachment to prevent unauthorized removal.
  - 3. Locations Other Than Terminal Posts: Breakaway (swing down) type designed to give way when a torque load of 40 to 50 foot pounds is applied to the arm.
  - 4. Terminal Posts: Match other extension arms, except breakaway feature may be deleted to accommodate erection procedures if required. Extension arms other than break away must require approval.
- E. Post Tops:
  - 1. Weather tight closure cap for tubular posts.
  - 2. One for each exposed tubular post end where equal protection is not afforded by combination post cap/extension arm.
  - 3. Post tops must permit permanent attachment to post without welding. Provide mechanical attachment to prevent unauthorized removal.
- F. Truss Assembly: Capable of withstanding 2,000 pounds tension consisting of minimum 1/2 inch truss rod with truss tightener or turnbuckle.
- G. Boulevard Clamps: Two piece clamp, minimum 12 gauge with 5/16 inch carriage bolts and nuts.
- H. Brace Bands: One inch size minimum 12 gauge with 5/16 x 1-1/2 inch carriage bolts and nuts.
- I. Rail Ends: Weather tight closure for tubular rails and braces.
- J. Hog Rings: 18-gauge stainless steel for attachment of barbed tape; 9-gauge galvanized steel at all other locations.

K. Tie Wire: 6-gauge galvanized steel wire, unless otherwise indicated.

# 2.3 GATES

- A. Gate Frames: Type I pipe members, 2.375-inches OD unless otherwise indicated.
- B. Provide truss rods of 3/8-inch minimum nominal diameter to prevent sag or twist.
- C. Provide vertical intermediate bracing of gate leaves, spaced so that members are no more than 8 feet apart.
- D. Provide horizontal gate leave braces as required to provide rigid construction, free from sag or twist.
- E. Gate Fabric: Match fence fabric.
- F. Attach fabric to frame at intervals not exceeding 12 inches. Secure with tension bars, tension bands, and 6-gauge steel wire.

# 2.4 GATE HARDWARE

- A. Hinges:
  - 1. Rated heavy duty and sized for the supported gate, with large bearing surfaces for clamping in position.
  - 2. Hinges must not twist or turn under the action of the gate.
  - 3. Hinges must not allow the gate to be lifted without first removing the hinges.
  - 4. The gates must be capable of being opened and closed easily by one person.
  - 5. Hinges must be suitable for exterior use.
  - 6. Weldable Gate Hinges: Extra Heavy Duty Roller Bearing Hoover Fence model # CI3520.
- B. Latches:
  - 1. Padlockable vertical slide bolt assembly
  - 2. Installed assembly must be capable of retaining gate in a closed position
  - 3. Installed assembly must be capable of withstanding a force of 500 pounds in any direction at any point in such a manner as to create the greatest stress on the locked assembly, without releasing the mechanism or allowing the gate to open. After the force is removed, the mechanism and gate must be without damage and continue to function as designed.
  - 4. Latches must be arranged for locking with specified locking hardware

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- 5. Gates and posts must be modified as required to receive hardware, including locking and operating mechanisms as herein specified.
- C. Hold-Open-Stop
  - 1. Mechanical device which automatically engages the free end of the gate leaf when in the full open position and holds it in the open position until manually released.
  - 2. Provide hold open stops for manually operated swinging vehicle gates.
- D. Sliding Gates (Not Used)
- E. Ports (Not Used)
- F. Padlocks
  - 1. Padlocks must be Master Padlock #6230.

# 2.5 GATE-HARDWARE GROUPS

- A. Double Leaf Vehicle Swing Gates (12-feet to 18-feet wide) with manual operation and locks.
  - 1. Lock: Padlock
  - 2. Center drop rod or plunger bar must extend into a metal section set in concrete.
  - 3. Provide lock and padlock eyes as integral part of the latch, requiring one padlock for locking both gate leaves.
  - 4. Locking device must be constructed so center drop rod or plunger cannot be raised when locked.
- B. Pedestrian Manual Swing Gates (4-feet by 7-feet) with manual operation and manual lock.
  - 1. Padlock must lock a gravity drop bar that engages a tongue attached to the gate frame. Drop bar must have positive stops to prevent opening the gate without first removing the lock and raising the drop bar.
  - 3. Shackle must allow swinging the lock between gate frame and adjacent post so lock can be opened from either side of fence.

## 2.6 FINISHES

- A. Components Not Otherwise Indicated: Zinc-coated ASTM A123
- B. Hardware Not Otherwise Indicated: Zinc-coated ASTM A153
- C. Galvanizing Repair Compound: Rust-Oleum 7000 Cold Galvanizing Compound

# PART 3 - EXECUTION

#### **INSPECTION** 3.1

Α. Verify grade provides flat surface allowing gate and fence construction with gap no more than 1-1/2 inches between bottom of bottom rail and the ground or grade beam.

#### 3.2 **INSTALLATION**

- Α. Install chain link fences and gates as indicated on the approved shop drawings and as follows.
- Β. Erect fencing in straight lines between angle points.
- С Postholes:
  - 1. Depth:
    - Minimum 24 inches plus 3 inches for each foot or fraction thereof а that post exceeds 4-foot projection above grade.
    - b. Greater if indicated
  - 2. Diameter:
    - Minimum four times post diameter, or 12 inches, whichever is a. greater.
    - b. Greater if indicated
  - 3. Work concrete into post holes to leave no voids.
  - 4. Provide crown watershed finish on the top surface of concrete.
  - 5. Coordinate with Building Contractor for placement of posthole/sleeve in building foundation where fencepost terminates at or near building.
- D. Grade Beams: At all locations without concrete or asphalt paving on both sides.
  - 1. Size: 24 inches deep, 30 inches wide
  - 2. Work concrete into grade beams to leave no voids
  - 3. The top surface of the grade beam must have a crown watershed finish. unless otherwise indicated or unless field conditions require sloping in one direction in order not to trap water runoff.
- E. Posts:
  - 1. Space posts equidistant in the fence-line not more than 10 feet on centers and in true lines.
  - 2. Set posts plumb and with 3 inches of concrete under post.

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- F. Terminal Posts:
  - 1. Terminal posts must be used at beginning and end of each continuous length of fence, at changes in vertical or horizontal alignment of 15 degrees or more, and at intervals not exceeding 800 feet.
  - 2. Where straight runs are greater than 800 feet, space terminal posts evenly between corner or end posts.
  - 3. Where posts terminate at or near a building, coordinate with Building Contractor to install fence post sleeves in the building foundation.
- G. Tension Wire:
  - 1. Install 1 foot from the top of fence fabric.
  - 2. Pull taut prior to installing chain link fabric.
  - 3. Secure at every post such that there must be no perceivable movement between the wire and the posts when the fabric is flexed.
  - 4. Fasten to posts with wire ties.
- H. Rails, Braces, and Truss Assemblies:
  - 1. Install on the side of the fence least accessible to inmates.
  - 2. Connect rails to posts using boulevard clamps or rail ends with brace bands.
  - 3. Connect pipe braces to posts using rail ends with brace bands.
  - 4. Brace gate and terminal posts to adjacent line posts with a horizontal pipe compression member (intermediate rail), diagonal truss assembly tension member and diagonal pipe compression member as indicated.
- I. Bottom Rail:
  - 1. Where grade beam is used, anchor bottom rail to grade beam.
  - 2. Anchor bottom rail to grade beam with 3/8-inch diameter U-shaped hooked anchors extending 6 inches into grade beam.
  - 3. Where longitudinal slope of top of grade beam exceeds 1:12, space anchors 1 foot 2 inches on center maximum.
  - 4. Space anchors 3 feet 4 inches on center maximum at other locations.
- J. Intermediate Rail: Install intermediate rail at mid height.
- K. Threaded Connectors and Accessories
  - 1. Peen threaded connectors and accessories after installation.

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- L. Fence Fabric:
  - 1. Allow concrete to obtain sufficient strength before installing fence fabric.
  - 2. Fasten fabric to terminal and gate posts with tension bars and tension bar bands.
    - a. Stretch fabric taut
    - b. Space tension bar bands not more than 12 inches on center
  - 3. Secure fabric to rails and line posts with wire ties at maximum 12 inches on centers.
    - a. Place tie within 6 inches of top of fabric and within 6 inches of bottom of fabric.
    - b. Weave tie wire through the fence fabric completely around the rail or post and twist wire securely with three twists on the rail or post side of the fence. Cut off the tails of the wire to preclude untwisting by hand.
    - c. Twist must be on side of fence least accessible to occupants.
  - 4. Secure fabric to top tension wire with hog rings at 24 inches on center. Cinch hog rings so that ends pass.
  - 5. Horizontal splicing of fabric on 18-foot high fences is permitted as shown on the Contract Documents.
  - 6. Vertical splicing of fabric is permitted if both pieces of fabric are woven together.
  - 7. Completed fabric installation must pass Fabric Deflection Test.
- M. Extension Arms and Post Caps:
  - 1. Anchor to prevent rotation and removal. Welding must not be acceptable.
- N. Barbed Wire:
  - 1. Stretch single strand of barbed wire tight through outer slots of each extension arm and secure.
- O. Barbed Tape
  - 1. In addition to the chain link fence, install barbed tape where shown on the Drawings.
  - 2. Install on the top of the extension arm and secure each loop to the single strand of barbed wire and the top of the fence fabric with hog rings clinched so the ends pass.

- 3. Where 12-foot high fence terminates at a building, a coil of barbed tape must extend past the building and the face of the coil must be attached flat to the surface of the building. A second coil of barbed tape must be installed horizontally beneath the extension arms.
  - a. The second coil must extend 6 feet horizontally from the building and extend vertically down to 10 feet above the adjacent finish grade where possible.
  - b. The second coil of barbed tape must be secured to the single strand of barbed wire to the fabric and to the building.
- P. Gates:
  - 1. Modify gates and posts as required to receive hardware as specified. Obtain hardware templates from Contractor and fabricate lock pockets and supports for specified lock.
  - 2. The maximum clearance between the bottom of the gate in closed position and finished grade must be 1 inch. Verify that gates can freely swing or slide into full open position without dragging on finish grade surfaces.
  - 3. Unless otherwise indicated, install gate hardware on the non-secure or outside of gates and fences.
  - 4. Secure gate hardware firmly in position allowing no unintended movement.
  - 5. Use lock manufacturer's hardware for installing electric locks. Welding of locks to fence posts must not be acceptable.
  - 6. Coordinate delivery of locks with the Contractor and Owner's Representative. Pulling of wire and connections to locks and control panels is specified under Division 26 Electrical.
- Q. Temporary Construction Gates
  - 1. Locate where shown or directed by Owner's Representative.
  - 2. Temporary construction gates must be removed and the openings closed when directed by Owner's Representative.
  - 3. Remove gate posts, end posts not required for completed fence and close openings in fence.
  - 4. Install permanent fence to close openings using line posts and end posts as indicated.
  - 5. Weave together fabric at splices.
  - 6. Completed fence must not show evidence of temporary openings.

- R. Temporary Security Fences
  - 1. Install temporary fence in manner allowing maximum possible material reuse.
  - 2. Temporary security fence must match other fences specified in this Section, except as specified below.
  - 3. Grade beam is not required.
  - 4. Set terminal posts, gate posts, and every tenth line post (maximum 100 feet) in concrete sleeved footings.
  - 5. Set other line posts in soil using backfill for stabilization.
  - 6. Below Grade Barrier: Three foot width of fence fabric with the bottom two feet set in soil and the top foot projecting above grade.
    - a. Install at inner (patient side) fence only.
    - b. Lap above grade portion of barrier over above grade fence fabric.
    - c. Fasten barrier to fabric using hog rings at 12 inches on center longitudinally at grade and at top of barrier. Clinch hog ring so the ends pass.
  - 7. Remove temporary security fencing, except concrete, when directed by Owner's Representative. Salvage removed material, except expendables such as tie wires.
  - 8. Disassemble salvageable materials in manner to avoid damage beyond normal wear and tear. Contractor will be assessed cost of replacement materials.
  - 9. Return salvaged materials to the Facility at on-site location directed by Owner's Representative.
  - 10. Conduct metal sweep after removal of temporary fence.
- S. Electrically ground chain link fences and gates under provisions of Section 26 05 26.

# 3.3 ERECTION TOLERANCES

- A. Maximum variation from plumb: 1/4 inch
- B. Maximum offset from true position: 1 inch
- C. Maximum distance between post and vertical edge of building must not exceed 3 inches
- D. Maximum clearance between bottom of bottom rail and top of grade or grade beam: 1-1/2 inches

# 3.4 BARBED WIRE (BW) AND WIRE MESH (WM) FENCE

A. In accordance with Caltrans Specifications, Sections 80-3.01A, 80-3.01C, 80-3.01D, and 80-3.01F except paragraph two.

## 3.5 FENCE FABRIC DEFLECTION TEST

- A. Contractor must test fence fabric deflection by applying a force of 30 pounds to the fabric in the center of each panel perpendicular to the plane of the fabric.
- B. Deflection of fence fabric must be no greater than 2 inches during the application of the force.
- C. Fabric must return to original position when force is released.

#### 3.6 GRAVITY BAR TEST

- A. Owner's Representative will designate gravity bars to be tested.
- B. Contractor must apply a 500-pound test load to designated gravity bars as directed by the Owner's Representative.
- C. Release load and verify proper operation of gravity bar and gate.
- D. Replace components damaged by test and retest. Repeat this sequence until components pass test.

#### 3.7 MANUFACTURER'S REPRESENTATIVE

A. Manufacturer's representative of barbed tape must be on the construction site at the commencement of installation to provide installation instructions and at other times as requested by the Owner's Representative.

#### 3.8 ADJUSTING

- A. Adjust operable components for smooth even operation.
- B. Field repair damaged galvanized surfaces in accordance with 2.6-C above, and one coat of brush-applied galvanizing repair compound to 3-mil dry film thickness.
## SECTION 33 42 11

## STORMWATER GRAVITY PIPING

## PART 1 GENERAL

- 1.01 SUMMARY
  - A. Section Includes:1. HDPE Stormwater Piping
  - B. In accordance with Caltrans 2018 Standard Specifications, except as noted herein.

## 1.02 SUBMITTALS

A. Stormwater piping submittal per Caltrans Section 64-2.01C.

## PART 2 PRODUCTS

- 2.01 NO MATERIALS SHALL BE DELIVERED TO THE SITE THAT ARE NOT IN CONFORMANCE WITH THESE SPECIFICATIONS, OR UNLESS ACCEPTED BY THE ENGINEER IN WRITING.
  - A. HDPE Stormwater piping per Caltrans Section 64, Type S.

### PART 3 EXECUTION

## 3.01 GENERAL

A. In accordance with applicable Caltrans Sections 64.

END OF SECTION

## SECTION 33 44 43

## VORTEX-TYPE HYDRODYNAMIC SEPARATORS

## PART 1 GENERAL

### 1.01 SCOPE

- A. Work described in this section includes furnishing all labor, equipment, materials, tools, and incidentals required for a complete an operable installation of the First Defense® High Capacity (FD-HC) stormwater treatment system, or approved equal, as shown on the drawings and specified herein.
- B. The manufacturer shall design and supply the equipment specified herein.

## 1.02 GENERAL REQUIREMENTS

A. The treatment system shall use an induced vortex rotational flow to separate pollutants from stormwater runoff. The system shall be self-activating with no mechanical parts or external power requirements.

## 1.03 SUBMITTALS

- A. Submittals shall be provided and shall include the following:
  - 1. Site plan showing location and orientation of proposed pipe sizes, connections, and excavation limits.
  - 2. Product installation drawings showing plan and elevation views with water elevations for the flow conditions specified herein, and as shown on the drawings.
  - 3. Certificate of Compliance Upon request, the manufacturer shall provide a "Letter of Certification" to certify that the treatment system adheres to the specifications required herein and complies with the project's stormwater management permit.
  - 4. Performance data as required in Paragraph 2.02.
  - 5. Upon request, independently certified performance data shall be made available to the Engineer of Record for use in determining that the treatment system meets the design criteria and performance requirements stated herein.
  - 6. Inspection and maintenance procedures.

#### 1.04 QUALITY ASSURANCE

- A. Inspection The treatment system shall be subject to inspection by the Engineer of Record or the owner's representative upon delivery to the project site. All defects shall be repaired to the satisfaction of the owner or owner's representative, and/or treatment system shall be replaced in its entirety depending on the severity of the damage, at no additional cost to Owner.
- B. Warranty The manufacturer shall guarantee the treatment system free from defects in materials and workmanship for a period of two years following installation and acceptance of the Work by Owner. If during the warranty period defects in materials or workmanship are noted, then the manufacturer shall be promptly notified. The decision to repair or replace affected units shall be

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mutually agreed upon by Oner and Manufacturer; any disputed Work shall follow the protocol established in the General Conditions.

- C. Patent Indemnity Upon request, the manufacturer shall warrant that the treatment system does not infringe upon or violate any patent, copyright, trade secret or any other proprietary right of any third party and shall indemnify the Owner against any loss, cost, expense, or liability arising out of such claim whether or not such claim is successful.
- D. Supplier / Manufacturer The treatment system shall be manufactured and/or supplied under the direction of a company(s) with at least 10 years' experience in the design, manufacture, and supply of stormwater treatment equipment.

## 1.05 SHIPMENT, STORAGE AND HANDLING

- A. The treatment components of the treatment system shall be delivered within six weeks of date of approved technical submittal unless agreed otherwise.
- B. The components of the treatment system shall be preassembled and delivered to the site fully fabricated and ready for the final assembly and installation.
- C. Off-loading, storage, and installation shall be by the Contractor.
- D. The Contractor shall inspect and provide signed acceptance of equipment prior to unloading or notify the manufacturer of any damage to equipment to effect proper remedial action. Failure to notify the manufacturer of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.
- E. The Manufacturer shall be notified immediately of any equipment which is damaged during unloading, on-site storage, or installation. The damaged equipment shall be repaired or replaced at no additional cost to Owner.

## PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Treatment Device The treatment device shall use an inlet chute and outlet chute to create a rotational flow within a cylindrical treatment chamber, with dual integrated bypass weirs. Access to the sump shall be via a central round access port, free of obstructions, located directly beneath the manhole access casting. No entry shall be required to maintain the Device and no internal parts moved or removed to access the sump.
  - B. Water Quality Flow (WQF) The flow rate at which the Device must achieve the pollutant reduction standard required. Flows in excess of the WQF are considered bypass flow.
  - C. Headloss The treatment system shall not exceed the pressure drop (headloss) for the design flow rates specified herein as determined by ASTM C1745 / C1745M 11.
  - D. Site The treatment system shall meet the design intent shown on the drawings and specified herein, and shall fit within the Project area shown.

- E. Storage Capacities The storage capacities shall not be less than the volumes listed in Table 1. The treatment system shall operate as intended and perform as specified herein as pollutants accumulate. The accumulation of pollutants that settle shall not reduce the volume required in the treatment system for separation and for preventing re-suspension and washout or reduce the floatables storage volume capacity.
- F. Access Minimum 24-inch frame and cover shall provide access to the sediment storage volumes from the surface for inspection and maintenance. Removal of pollutants from the treatment system shall be possible without requiring confined space entry.
- G. Manhole and Access Covers All manholes and castings shall conform to relevant AASHTO and ASTM standards including any local and job specific requirements that may exceed these standards.
- H. Grout All manhole penetrations shall be sealed with non-shrink hydraulic cement.

## 2.02 PEFORMANCE REQUIREMENTS

- A. The Device shall be sized based on treating the WQF calculated using the locally approved methods, or standard methods outlined in the applicable design guides and regulations.
- B. The Device shall meet the performance and capacities specified in Table 1 for a 3 ft diameter manhole.
- C. Treatment Flow Performance of the treatment system shall be based on treating the Water Quality Flow rate without re-suspension and washout of captured pollutants scour).

WQF	WQF	Sediment Storage
(cfs)	min. 80% TSS 110 μm	Capacity
	(50- 150 µm)	(cuyd)
	(cfs)	· · · /
0.85	1.06	0.4
1.5	1.88	0.7
	WQF (cfs) 0.85 1.5	WQF (cfs) WQF min. 80% TSS 110 μm (50- 150 μm) (cfs)   0.85 1.06   1.5 1.88

Table 1

- D. The treatment system shall be manufactured with materials typically used in stormwater drainage systems that have a minimum life expectancy of 30 years.
  - 1. Materials of construction shall be cross-linked polyethylene (XLPE) and/or Type 304 stainless steel. All components shall be designed to withstand normal loadings associated with fabrication, shipping, site installation, and normal operation of the equipment
  - 2. Precast shall be manufactured with concrete that has attained a compressive strength of 4,000 psi after 28 days. The structure shall be reinforced to withstand an HS20-44 loading. Shiplap joints shall be sealed with butyl rubber mastic sealant conforming to ASTM C990. Slab tops shall be suitably reinforced and provided with manhole openings and covers as required. The cast iron manhole frames and covers shall be

sized as per the manufacturer's drawings and shall be in accordance with ASTM A48, CL.35B and AASHTO M105. The masonry fixing bolts shall be Type 304 stainless steel.

- 3. All piping connections and ancillary connections, grade ring, and items not listed herein shall be provided by the Contractor.
- 4. Any local applicable standards or project unique requirements must be read in conjunction with this specification.

## PART 3 EXECUTION

## 3.01 GENERAL

- A. The system shall be installed in strict accordance with the site plans, and the manufacturer's general arrangement drawings and handling, storage and installation instructions. The Contractor shall be responsible for installing the equipment and all necessary site connections.
- B. The precast concrete structure shall be set on a granular or compacted sand sub-base in accordance with local requirements for standard manhole installation. In no instances shall the compacted sub-base material have a thickness of less than 12 inches.
- C. The precast concrete structure shall be set level and plumb to within 0.5%.
- D. Non-shrink grout or hydraulic cement conforming to ASTM C 595 shall be used to provide a watertight seal in the lift holes, any drain holes, and around the concrete knock-outs for the inlet and outlet pipes.

# END OF SECTION

## SECTION 33 46 11

## STORMWATER PONDS

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. This work includes furnishing and installing bioretention soil media (BSM) to the dimensions shown on the plans. BSM must comply with the plans and these specifications.
- B. Earthwork and grading for the stormwater retention pond shall be in accordance with the plans, and Section 31 11 11, Earthwork.

#### 1.02 SUBMITTALS

A. A minimum of 14 calendar days before starting the Work, submit BSM material submittals for both the mature compost and sand for approval by the Engineer.

#### PART 2 PRODUCTS

#### 2.01 MATERIALS

A. BSM shall be comprised of:

Material	Percent By Volume
Mature Compost	30 - 40%
Sand	60 - 70%

#### 2.02 MATURE COMPOST

- A. Compost must be derived from one or a combination of the following types of materials:
  - 1. Green material consisting of chipped, shredded or ground vegetation or clean, processed recycled wood products
  - 2. Biosolids must not be derived from mixed, municipal solid waste and must not contain paint, petroleum products, pesticides or other chemical or deleterious residues harmful to plant or animal life. Compost shall be free of inert ingredients, including glass, plastic and paper.
  - 3. Mixed food waste
- B. Mature compost must arrive on site at a temperature < 120° f and meet at least one of the following stability methods:

Method	Units	Requirement
NH4: NO3-N RATIO	None	< 3
Total NH3 - N	PPM	< 500
Seed Germination	Percent	> 80 of control
Plant Trials®	Percent	> 80 of control
Solvita®	Index Value	> 5

C. Mature compost must meet at least one of the following maturity indices in the following table.

Method	Units	Requirement
Sour Test	O2 / Unit TS / HR.	< 1.3
Sour Test	O2 / Unit BVS / HR.	< 1.5
CO2 Test	C / Unit VS / DAY	< 8
Dewar	Temp Rise (degrees C)	< 20
Solvita®	Index Value	> 5

D. Compost must comply with the following gradation requirements below:

Sieve Size	Percent Passing (by weight)
1 inch	99 – 100
1/2 inch	90 – 100
1⁄₄ inch	40 – 90
No. 200	2 – 10

E. Compost must comply with the requirements shown in the following table:

Property	Requirement
Bulk Density	500 and 1100 dry lbs./cubic yard
Moisture Content	30% to 55% of dry solids
Inert Materials	< 1 % by weight or volume combined total
Carbon : Nitrogen Ratio	15:1 < C:N < 25:1
Salinity	< 6.0 MMHOS/CM
pН	6.5 < pH < 8.0
Total Nitrogen	> 0.9%
Boron	< 8 ppm dry, < 2.5 ppm soluble

1. TMECC = Test Methods for the Examination of Composting and Compost

#### 2.03 SAND

A. Sand shall meet the requirements for ASTM C33 for fine aggregate, or the following gradation requirements:

Sieve Size	Percent Passing (by weight)
3/8 inch	100
No. 4	90 - 100
No. 8	70 – 100
No. 16	40 – 95
No. 30	15 – 70
No. 40	5 – 55
No. 100	0 – 15
No. 200	0 – 5

#### PART 3 EXECUTION

- 3.01 CONSTRUCTION
  - A. BSM shall not be mixed on site.
  - B. Scarify subgrade 12" before installing BSM.

- C. Compact BSM in 6" lifts with landscape roller or by light wetting, to the thickness shown on the drawings. Do not over-compact or allow heavy equipment over BSM.
- D. Allow BSM to dry overnight before any planting is installed.

END OF SECTION