SECTION 012300 - OPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for options.

1.2 DEFINITIONS

A. Option: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Options described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each option is the net addition to or deduction from the Contract Sum to incorporate options into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the option into Project.
   1. Include, as part of each option, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted options under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Options" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF OPTIONS

A. Additive Option No. 1, Whole Campus Water Filtration System:
   1. Base Bid: Provide plumbing equipment BP-1 and WT-2 as indicated on Sheet P7.2, and specified in Section 223200 - Domestic Water Filtration Equipment.
   2. Option: Provide whole campus water filtration system as indicated on Sheets P2.1.PH, P7.1.PH, P5.2.1, P7.2, and specified in Section 223200 - Domestic Water Filtration Equipment.

B. Additive Option No. 2, Spray Fields at Hon Dah Waste Water Treatment Plant:
   1. Base Bid: No Spray Fields.
   2. Option: Provide Spray Fields as indicated on Sheets LI1.0.0, LI5.0.0.

C. Additive Option No. 3, Acoustic Floor System:
   1. Base Bid: Provide floor at Warehouse as indicated on Sheet S2.2.1E.

2. Option: Provide acoustic floor system at Warehouse as indicated on Sheet S2.2.1E, and specified in Section 035400 – Cast Underlayment.

D. Additive Option No. 4, Circadian Lighting System:
1. Base Bid: Provide lighting as indicated in Electrical Drawings and specified in Division 26.
2. Option: Provide line-item pricing for circadian lighting system (tunable white) and required controls by functional area in the following list. Spaces are selected to emphasize non-transitional areas where patients and staff spend extended periods such as patient rooms, nurse stations and corridors, open and closed offices, and in-patient areas. Clinical support spaces and operating rooms are not included. System shall be selected to maintain photometric and aesthetic performance to Basis of Design with preference to exact fixture matches where possible and similar type and form factor where exact matches are not available. The system shall be capable of modulating light output and color temperature over a 24hr time cycle between 2200 and 6500 kelvin with both automated networked and user manual control per IES recommendations for healthcare circadian lighting.
   a. Acute Care
   b. Administration
   c. Behavioral Health
   d. Emergency Department
   e. Labor and Delivery
   f. Specialty Care

E. Additive Option No. 5, Bipolar Ionization Air Filters:
1. Base Bid: Bid Documents as shown.
2. Option: Provide bipolar Ionization air filters as indicated on Sheets M6.1, M6.2. M6.3, and M7.2, and specified in Section 238610 - Bi-Polar Ionization Air Purification System.

F. Additive Option No. 6, Photovoltaic System and Video Surveillance Cameras:
1. Base Bid: Provide infrastructure and equipment for emergency help points and video surveillance cameras as shown on Sheets T1.2.1 and TY1.2.1, and as specified in Sections 275123 - Emergency Help Points And Call Boxes, and 282300 - Video Surveillance. Cameras and emergency help points shall be identical to others in the Project design. See sheet keynotes for additional information.
2. Option: Provide photovoltaic system and video surveillance cameras as indicated on Sheets T1.2.1 and TY1.2.1, and specified in Sections 282300 that will replace the emergency help points. See Drawings for exact locations and quantities. See sheet notes for additional information

G. Additive Option No. 7, Acoustical Panels:
1. Base Bid: Provide finishes in Conference Rooms as shown in AI Series Drawings.
2. Option: Provide acoustical panels as shown on AI Series Drawings and as specified in Sections 098433 – Sound Absorbing Wall Units and 097723 - Fabric-Wrapped Panels.

H. Additive Option No. 8, Hon-Dah Utility Campus:
   1. Base Bid: No Hon-Dah Utility Campus.
   2. Option: Provide Hon-Dah Utility Campus per Building Package No. 3 (BP3).

I. Additive Option No. 9, PLC Cabinets at Surface Water Treatment Plant:
   1. Base Bid: Provide new PLC cabinet, PLC programming, operator interface programming, and modifications to the 3 existing PLC's for the new Tonka treatment unit as indicated on the SWTP plans and as specified in Specification Section 460713.
   2. Option: In addition to the Base Bid, remove and replace the 3 existing PLC cabinets and internal components with new PLC cabinets and internal components, including PLC and operator interface programming. New PLC and internal components to match the new PLC for the new Tonka treatment unit, as specified in Specification Section 460713.

J. Additive Option No. 10, Radon Mitigation (Add. A)
   1. Base Bid: No Radon Mitigation
   2. Option: Provide delegated design and installation of an Active Soil Depressurization (ASD) radon mitigation system that follows ANSI/AARST standards and EPA Guidelines for system designs, installation, and verification. System shall be installed on the lowest level of the building with ventilation extending from the lowest level of the building up to the second-floor roof level. Ventilation locations at the roof level shall be approved by the Architect prior to Installation. (Add. A)

END OF SECTION

Set: 180.0
Doors: IPC-3256A, IPC-3258A, IPC-3259A, IPC-3263A, IPC-3264A, IPC-3267A, IPC-3268A, IPC-3271A, IPC-3272A, IPC-3275A, IPC-3276A, IPC-3278A, IPC-3279A, IPC-3281A, IPC-3282A, IPC-3285A, IPC-3286A, IPC-3287A, IPC-3295A, IPC-3296A, IPC-3297A, LAB-3241A, PRC-3237, RHB-4286, RHB-4287, RHB-4288, RHB-4292, RHB-4293, RHB-4294, RHB-4295, WIS-2286A, WIS-2287A, WIS-2288A, WIS-2289A

1	Side Wall Track Kit	280C-SWTKIT x soft close		PE	
2	Door Pull	111 Mtg-Type 5 BTB	US32D	RO	

Set: 181.0
Doors: SCC-4242

1	Side Wall Track Kit	280C-SWTKIT x soft close		PE	
1	Magnetic Lock	M32BD		SU	ϟ
1	Permanent Keyed Core	11 XC 6300 MK LA & LB (match existing)	US15	SA	
1	Mortise Cylinder	1164 42	US32D	SA	
2	Door Pull	111 Mtg-Type 5 BTB	US32D	RO	
2	Gasketing	S773BL face of door to wall		PE	
1	Door Bottom	2170_V		PE	
1	Relay	RB30		AS	
1	Wiring Diagram	Point to point system		AK	
1	Dress Cover	DC-32CL		SU	ϟ
1	Motion Sensor	XMS2		SU	ϟ
1	Pushbutton	EEB3N		SU	ϟ
1	Keyswitch	MK		SU	ϟ
1	Power Supply	AQL4-E1 w/fire alarm relay		SU	ϟ

Notes: Door is normally closed and locked. | Exterior access by presenting a valid credential to reader, momentarily de-energizing mag lock for entry. | Free egress at all times via motion sensor. | Redundant push to exit button. | Mag lock is integrated into the building's fire alarm system and is unlocked during alarm/power loss.

Set: 182.0
Doors: EMR-1261-2, EMR-1262-2, EMR-1263-2, EMR-1264-2, EMR-1265-2, EMR-1266-2, EMR-1267-2, EMR-1270-2, EMR-1271-2, EMR-1272-1, EMR-1272-2, EMR-1273-1, EMR-1273-2, EMR-1290-2, EMR-1291-2, EMR-1292-2

1	Track and Hardware	By STC frame/door sliding door assembly manufacturer Section **Revised 08-1473** ~~**083473.20**~~		**RS**	**(Add. A)**
2	Pull	S3110-B-12.75-0.75	630	**RS**	

Note, at doors EMR-1272-1,
Revised ~~**EMR-1272-2**~~, EMR-1273-1, **Revised** ~~**EMR-1273-2**~~ **(Add A.)**
Doors to have self-closing and latching hardware for smoke rated doors.

Public

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Doors.
   3. Glazed curtain walls.
   4. Storefront framing.
   5. Glazed entrances.
   6. Interior borrowed lites.
   7. Glazing sealants and accessories.

B. Related Requirements:
   1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
   2. Section 088113 "Decorative Glass Glazing."
   3. Section 088813 "Fire-Rated Glazing."

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Fabrication: Using primary glass in the production of single pane glass products such as coated, laminated and heat treated glass. Can be done by either the Glass Manufacturer or the Glazing Product Manufacturer.

C. Glazing Product Manufacturer: Firm that uses fabricated glass in the production of insulating glass (multiple panes of glass).

D. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

E. IBC: International Building Code.

F. Interspace: Space between lites of an insulating-glass unit.

G. Large Glass Lites and Insulating Glass Units: Over 55 SF.

H. Structural Glazing Product Manufacturer: Firm that produces insulating glass for use in a structural glazing system.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.
   3. Review glazing systems included in Project and specified in other Sections.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of glass product and glazing material specified.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:
   1. Submit shop drawings of glazing details. Draw details minimum full size (twice full size preferred) and indicate dimensions, tolerances, and materials.
   2. Submit shop drawings for structural sealant glazing after review and approval of shop drawings by sealant and glass product manufacturers.

D. Glass Samples:
   1. Each type of monolithic and laminated glass, except clear monolithic glass, no less than 3 by 6 inches.
   2. Each type of insulating and insulating laminated glass, no less than 12 by 12 inches, including type of edge seal, spacer, and corner construction of spacer. Identify specific type of reflective and Low-e coated glass, coated surfaces, and exterior face of unit.
   3. Each type of spandrel glass, no less than 12 by 12 inches.

E. Exposed Glazing Accessory Samples: For gaskets, sealants, and colored spacers, in 12 inch lengths. Install sealant samples between two strips of material representative in color of the adjoining framing system after sealant color selections have been made.

F. Other Glazing Accessory Samples:
   1. Corner construction of compression gasket for dry glazing with each leg approximately 6 inches long.
   2. Tape sealant, 6 inches long.
   3. Compression wedge, 6 inches long.
   4. Channel gasket, 6 inches long.
   5. Bed gasket, 6 inches long.
   6. Face shim or spacer.
   7. Setting block.
   8. Edge block.
   9. Compressible filler.
   10. Open cell filler.

G. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

H. Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
   1. Provide delegated-design submittals for glass.

I. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, glass testing agency, and sealant testing agency.

J. Product Certificates:
   1. Submit statement from glazing product manufacturer stating that glazing products meet the requirements of the specified standards, the project specifications, and that there is no incompatibility of glazing materials with the insulating glass unit sealants.
   2. Provide glass fabrication manufacturer's statement that they have reviewed and approved the application of the glazing details for the project.
   3. Upon request, submit reports indicating results of distortion and flatness monitoring and inspection for laminated and heat treated glass and for continuous on-line color measurement via spectrophotometer inspection device.
   4. Submit statement from structural glazing product manufacturer indicating the following:
      a. The details of construction have been reviewed and are approved for use with the glass products.
      b. The secondary seal of insulating glass units has been designed and sized to resist the applied loads.
      c. The Contractor's quality assurance program has been reviewed and is approved.
   5. Submit statement from structural glazing sealant manufacturer indicating that structural sealants have been tested prior to installation and conform to the requirements of the Contract Documents and the following:
      a. The structural sealant meets ASTM C1184.
      b. The structural sealant is compatible with specified sealant backing and spacer materials as determined by ASTM C1087.
      c. The structural sealant is compatible with and does not adhere to specified bond breaker and spacer materials as determined by ASTM C1087.
      d. The structural sealant is compatible with the insulating glass unit edge seal.
      e. The structural sealant is compatible with and has been tested for adequate adhesion to each respective substrate.
      f. The details of construction have been reviewed and are approved for use with the structural sealant.
      g. The design stress of the sealant due to the application of the primary forces does not exceed 20 psi.
   6. If any of the above required statements involve more than one manufacturer, submit certificates from each of those manufacturers.

K. Glazing Analysis:

1. For exterior glazing, provide an analysis confirming all in service thermal stressing of the glass has been evaluated and that expected thermal stressing will not exceed the strength capacity of the glass and the glass is acceptable for the anticipated in-service conditions of exposure. All such analysis shall be performed by experts experienced in analyzing thermal stressing of glazing due to in service environmental conditions utilizing appropriate engineering means of thermal stress analysis.
    a. Provide copy of analysis and summary report.
    b. Analysis shall include consideration for the following conditions where applicable:
        1) Thermal properties of the glass units, including laminate interlayers, coatings and applied frits, and thermal spacers in the case of insulated units.
        2) Geographic and weather conditions of the building site.
        3) Solar orientation of the glass units.
        4) Impact of shading by adjacent structures.
        5) Glazing system's properties that may impact temperature differentials within the glass units.
        6) Highly reflective surfaces in the immediate area which may impact temperature differentials within the glass units.
        7) Shading of glass units by properties of the building configuration including, but not limited to, fins, projections, changes in building lines in plan, overhangs, projections, and similar physical attributes.
        8) Glazing conditions including spandrels and shadow boxes including back pans and insulation layers on the inboard side of the glass.
        9) Interior conditions nearby the glass which may impact glazing unit temperatures including pockets resulting from interior configurations, interior shading or other window treatment devices, and mechanical heating or cooling systems.
        10) Consideration for potential loss of strength of glass due to application of frits or coatings.
        11) Industry standard ranges of strength for annealed, heat strengthened, or tempered glass units unless fabricator/manufacturer can demonstrate strength properties outside of these ranges.
        12) Consideration for predictability of post fabrication heat forming of glass units.
        13) Heated framing systems.

L. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for tinted glass, coated glass, insulating glass, glazing sealants, and glazing gaskets.
    1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

M. Preconstruction adhesion and compatibility test report.

N. Quality Assurance Program (QAP):

1. Glass fabrication: Written QAP including but not limited to reference of applicable ASTM testing methodology, type and frequency of in-line monitoring of glass fabrication, and reporting and documentation. Test sample lite of glass, at Contractor™™s expense, for conformance to:
   a. Bow and warp.
   b. Localized distortion/roller wave.
   c. Concavity/convexity.
   d. Compression strength.
   e. Distortion and Flatness Monitoring and Inspection Device for Laminated and Heat Treated Glass: Osprey 8 by LiteSentry.
2. Installation: Written QAP to monitor quality of products such as cleaners, solvents, primers, and sealants; and sealant workmanship including, cleaning, priming, joint opening preparation, and sealant installation.
   a. Include as part of program random adhesion and compatibility testing of production run products.
   b. Do not install sealant work prior to review of program.
   c. Submit quality assurance program to glass and sealant manufacturers for review and approval prior to submission to Architect.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. **Per** ~~**At**~~ Owner's direction, and prior to construction completion, furnish for future maintenance and repair, the following glass types for attic stock: **(Add. A)**
   1. ~~**Furnish 5 percent of quantity for each size and type but not less than 1, nor more than 6 units for each size of each type of rectangular shaped units. (Add. A)**~~
   2. **Furnish 2 each, for each color of laminated color glass piers per detail 7/LS5.0.0 (Add. A)**

B. Units for attic stock shall be adequately crated and identified as to storage conditions, unit type, size, surface to be glazed to exterior, and any other pertinent information to assist the Owner in future maintenance.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited in accordance with the NFRC CAP 1 Certification Agency Program.

C. Sealant Testing Agency Qualifications: An independent testing agency qualified in accordance with ASTM C1021 to conduct the testing indicated.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Glazing mock-up: Produce three full-sized IGUs for review and approval by the Architect before full production run.
   2. Install glazing in mockups specified in Division 08 Section "Aluminum-Framed Entrances and Storefronts, and Glazed Aluminum Curtain Walls " to match glazing systems required for Project, including glazing methods.

3. Approved sample installation may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Place mockup where reflection from adjacent buildings or other structures with a regular pattern can be used to gauge overall appearance / distortion of the glass.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F. Do not install sealants to wet or frost covered surfaces.

1.11 WARRANTY

A. General: During the warranty period, restore defective Work to the standard of the Contract Documents, including all labor, materials, refinishing and other costs incidental to the Work. Restore Work found to be defective as defined in the Contract Documents. The warranty period starts at the date of Substantial Completion.

B. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.

D. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

E. Manufacturer's Special Warranty for Heat Soaking of Tempered Glass: Manufacturer agrees to replace heat soaked tempered glass units that fail. Warrant that heat soaked tempered glass will not spontaneously break as a result of nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000).
   1. Warranty Period: 10 years from date of Substantial Completion.

F. Installation: Glazing systems installation shall be warranted for a period of five years against defective materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND FABRICATORS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems indicated to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
   1. Obtain tinted glass from single source from single manufacturer.
   2. Obtain reflective-coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design glazing.
   1. Material properties indicated in this Section shall be considered as minimum properties.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300.
   1. Wind Load Design Criteria:
      a. As indicated on Drawings.
      b. Design Wind Pressures: Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings.
   2. Design Snow Loads: As indicated on Drawings.
   3. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
   4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
   5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing:
   1. CPSC 16 CFR part 1201, testing requirements of ANSI Z97.1, and listed in the SGCC Certified Products Directory with appropriate SGCC certification mark or label permanently affixed.
   2. Furnish safety glass for glass occurring in doors and sidelights, and where indicated and further required by authorities having jurisdiction.

E. Sound Control Glazing: Products with air borne sound transmission loss as measured by ASTM E90 and STC rating as classified by ASTM E413.

F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For laminated-glass lites, properties are based on products of construction indicated.
   3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.

5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
1. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where heat-strengthened float glass is indicated, provide heat-strengthened float glass unless fully tempered float glass is required to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

F. Low-E Coatings: For glazing requiring low-e coatings, comply with the following.
1. Provide a minimum of 95 percent edge deletion of low-e coating around the entire perimeter of the unit to ensure proper seal in insulated unit.
2. Utilize coated glass produced using continuous in-line color measurement via spectrophotometer inspection device.
3. Tolerance for color variation to be no greater than a total range of 4.5 delta E for color incident and at angle, based on measurement protocol described in ASTM C1376.
4. Transmitted and reflected color for all coated glass shall be consistent and fall on the same side of the neutral axis of the color spectrum as defined in ASTM D2244.

2.4 GLASS PRODUCTS

A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. Heat Soak Testing: For all fully tempered glass, provide heat soak testing conforming to EN14179 which includes a 2 hour dwell at 290 deg C, +/- 10 deg C.

B. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For uncoated glass, comply with requirements for Condition A.
3. For coated vision glass, comply with requirements for Condition C (other coated glass).
4. Limit Kind HS surface compression to upper end of ASTM C 1048 range, 7,500 psi.
5. Distortion Tolerances:
   a. Roller Wave: Maximum 0.003 inch from peak to valley within the main body of the sheet and maximum 0.008 inch within 10.5 inches of a leading or trailing edge.
   b. Localized Warp: Maximum 0.03 inch over any 12 inch span, but limited to 0.31 inch.

C. Low-E / Reflective-Coated Vision Glass: ASTM C1376.

D. Low-E / Reflective-Coated Ceramic Spandrel Glass: ASTM C1376, Kind CS, coated by vacuum deposition (sputter-coating) process, ASTM C1048, Condition B, Type I, Quality-Q3, and complying with other specified requirements.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Construction: Laminate glass with ionomeric polymer interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.
4. Glass Edge Alignment Tolerances:
   a. Concealed Laminated Glass Edge Offset:
      1) Edge length less than 80-inches: ±0.04-inch.
      2) Edge length greater than 80-inches: ±0.08-inch.
   b. Exposed Laminated Glass Edge Offset: The edges of the laminated glass plies shall be flush and level ±0.04-inch.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary seal, and with soldered, welded, and/or bent spacer corner construction.

a. Units for Structural Sealant Glazing: Dual seal construction of a polyisobutylene primary seal and silicone secondary seal, and with soldered, welded, and/or bent spacer corner construction.
b. Secondary Seal: Continuous, free of skips and voids.

2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.
4. Units which will be shipped through or glazed at altitudes of 5000 feet or more above sea level, fabricated with breather or capillary tubes, to permit air space pressure equalization. Provide same warranty as for non-breather or capillary tube units. Pinch tubes during glazing if required by glass manufacturer.
5. Flatness Tolerance: Manufacturer units so that maximum out-of-plane concavity/convexity, at center of each lite, does not exceed the following when ambient temperature is 70 degrees Fahrenheit and glass surface temperature is within +/- 5 degrees Fahrenheit of ambient temperature. Measure flatness with units installed in vertical position.
   a. Units 20 square feet and longer in area: + / - 1/16-inch maximum.
   b. Units smaller than 20 square feet: + / - 1/32-inch maximum.
   c. If units are manufactured at geodetic elevation higher or lower than that of the Project, take measures to assure that flatness tolerance are met. If filling or deflating is used at time of manufacture to compensate for elevation difference, it shall be done after full curing of glass edge seals.

2.7 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   1. Neoprene complying with ASTM C 864.
   2. EPDM complying with ASTM C 864.
   3. Silicone complying with ASTM C 1115.
   4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
   5. Compression wedge for dry glazing system: of shape and size to compress the exterior compression gasket a minimum of 25 percent, and as recommended by glazing and sealing systems manufacturer.
   6. Provide gaskets that are compatible with glazing sealants and will provide for silicone adhesion.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned silicone gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   1. Bed gasket for wet glazing system: continuous with pressure sensitive adhesive 1 side, designed to be compressed 25-40 percent in the opening.
   2. Compression gasket for dry glazing system: shape as required to be compressed in place a minimum of 25 percent and of one-piece construction with factory-assembled frames with injection-molded, vulcanized corners; produced oversize in opening dimension, as determined by measurements, to insure compression at corners but within limits so that compression does not create a "pucker".
   3. Channel gasket: continuous channel of shape and dimensions for application in the opening with specified glazing.

4. Provide gaskets that are compatible with glazing sealants and will provide for silicone adhesion.

2.8 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   3. Sealant shall have a VOC content of 250 g/L or less.
   4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   5. Colors of Exposed Glazing Sealants: Match Architect's samples.

B. Glazing Sealant:
   1. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 50, Use NT.
      a. Manufacturers: Subject to compliance with requirements, provide one of the following:
         1) Dow Corning Corporation; 756 SMS.
         2) GE Construction Sealants; Momentive Performance Materials Inc.; SilPruf NB SCS9000 .

2.9 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

C. For openings up to 75 united inches, use unshimmed tape. For openings over 75 united inches, use pre-shimmed tape.

2.10 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
   1. Each block shall be properly sized for load, as wide or wider than glazing, no less than 4 inches long; profile to permit friction fit, dart insertion into metal chair, or pressure sensitive adhesive one side to fix block in glazing opening.

D. Spacers: Elastomeric blocks or continuous extrusions of 40 to 60 Shore "A" durometer hardness to maintain glass lites in place for installation indicated.
   1. Profile to permit friction fit, dart insertion or pressure sensitive adhesive one side to fix shim or spacer in location.

E. Edge Blocks: Elastomeric material of 40 to 60 Shore "A" durometer hardness to limit glass lateral movement (side walking).
   1. Each block shall be a minimum of 4 inches long, as wide as glazing, placed in the vertical glazing channel, and sized to allow a nominal 1/8-inch clearance between glass edge and installed block; profile to permit friction fit or pressure sensitive adhesive one side to fix block in glazing opening.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Open Cell Filter: Reticulated flexible polyester urethane foam having 20 pores per inch, sized at least 1 inch larger in dimension than weephole, of cross section to provide 15 to 25 percent compression for friction fit and as manufactured by Foam Division, Scott Paper Co.; H-O Products Corp. or approved comparable product.

H. Bond Breaker: Heavy duty, 11-mil minimum thickness, colored, polyethylene or teflon, self-adhesive bond breaker of type recommended by sealant manufacturer and suitable for conditions of usage. Liquid bond breaker is not permitted.

2.11 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
   1. Ensure approved Quality Assurance Program is implemented.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
   1. Locate one quarter of glass width from each corner, but with block edge nearest corner no closer than 6 inches from corner, unless otherwise specified or required by glass manufacturer.
   2. Insulating glass used in sloped glazing shall have both panes supported by setting blocks.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

M. Where butted glass without mullions is indicated, seal open joints with silicone sealant in accordance with sealant and glass manufacturer's written instructions. Set glass so that joint is plumb and glass edges are aligned to provide for a uniform joint width of 3/8 inch maximum. Mask edges of glass to confine sealant to joints and to avoid contact with either face of glass. Use primer where required. Neatly tool joints to slightly concave surface using recommended tooling agent. Remove masking from glass and clean glass surfaces completely free of sealant material.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or backings in place and in position to control location and depth of installed sealant for required sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a smooth surface and on exterior applications provide a wash away from glass.

3.7 STRUCTURAL SEALANT GLAZING

A. Install continuous spacers between glass lites and glazing channels to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Perform no structural sealant glazing prior to written certification of adhesion and compatibility test results, review and written approval of glazing details by glass and sealant manufacturers, and acceptance of written quality assurance program.

C. Install glass in metal windows or framing with continuous spacer installed between glass and window or frame, setting blocks properly sized and located and structural sealant installed in properly sized and located cavity formed by glass, spacer and window or frame.

D. Provide installation that maintains glass face clearances and prevents sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or backings in place and in position to control location and depth of installed sealant for required sealant performance.

E. Perform installation procedures per written sealant and glass manufacturers' requirements and written quality assurance program.

F. Force sealants into glazing channels to eliminate voids and to ensure complete wetting and bond of sealant to glass and channel surfaces.

G. Tool exposed surfaces of sealants to provide a smooth surface and on exterior applications provide a wash away from glass.

H. Do not allow sealant to bleed into the interface between the glass and glazing spacer.

I. Structural sealant work shall be shop-glazed.

3.8 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

C. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

D. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

E. Remove and replace glass that is damaged during construction period.

F. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.9 MONOLITHIC GLASS SCHEDULE

A. Glass Type: Clear fully tempered float glass.
   1. Minimum Thickness: 6 mm.
   2. Safety glazing required.

3.10 LAMINATED GLASS SCHEDULE

A. Glass Type: Clear laminated glass with two plies of heat-strengthened float glass.
   1. Minimum Thickness of Each Glass Ply: 6 mm.
   2. Interlayer Thickness: 0.090 inch.
   3. Safety glazing required.

B. Glass Type: Colored laminated glass with two plies of heat-strengthened float glass.
   1. Minimum Thickness of Each Glass Ply: 12 mm.
   2. Interlayer Thickness: 0.090 inch.
   3. Safety glazing required.

3.11 INSULATING GLASS SCHEDULE

A. Glass Type GL-1: High Performance Vision Unit.
   1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon.
   2. Overall Unit Thickness: 1 inch.
   3. Minimum Thickness of Each Glass Lite: 6 mm.
   4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
   5. Coating: VNE-53 on #2 surface.
   6. Interspace Content: 1/2" VTS black spacer - Argon filled.
   7. Silicone: Black
   8. Indoor Lite: Heat-strengthened float glass, Pure Mid Iron.
   9. Visible Light Transmittance: 51%
   10. Exterior Reflectance: 20%
   11. Winter Nighttime U-Factor: 0.24.
   12. Summer Daytime U-Factor: 0.20.
   13. Shading Coefficient: 0.26
   14. Solar Heat Gain Coefficient: 0.22
   15. Light to Solar Gain Ratio: 2.32
   16. Safety glazing required.

B. Glass Type GL-2: (GL-1 with Painted Back Pan).
   1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon.
   2. Overall Unit Thickness: 1 inch.
   3. Minimum Thickness of Each Glass Lite: 6 mm.
   4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
   5. Coating: VNE-53 on #2 surface.
   6. Interspace Content: 1/2" VTS black spacer - Argon filled.
   7. Silicone: Black
   8. Indoor Lite: Heat-strengthened float glass, Pure Mid Iron; V957 SUBDUED GRAY on #4 surface.

9. Visible Light Transmittance: N/A
10. Exterior Reflectance: N/A
11. Winter Nighttime U-Factor: 0.24.
12. Summer Daytime U-Factor: 0.20.
13. Shading Coefficient: N/A
14. Solar Heat Gain Coefficient: N/A
15. Light to Solar Gain Ratio: N/A
16. Safety glazing required.

C. Glass Type GL-3: High Performance Vision Unit with Ceramic Frit.
1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
5. Coating: VNE-53 on #2 surface.
6. Ceramic Frit: V957 SUBDUED GRAY on #2 surface; print as indicated on Drawings.
7. Interspace Content: 1/2" VTS black spacer - Argon filled.
8. Silicone: Black
9. Indoor Lite: Heat-strengthened float glass, Pure Mid Iron.
10. Visible Light Transmittance: 32%
11. Exterior Reflectance: 17%
12. Winter Nighttime U-Factor: 0.24.
13. Summer Daytime U-Factor: 0.20.
14. Shading Coefficient: 0.18
15. Solar Heat Gain Coefficient: 0.16
16. Light to Solar Gain Ratio: 2.00
17. Safety glazing required.

D. Glass Type GL-4: High Performance Vision Unit with Decorative Film.
1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
5. Coating: VNE-53 on #2 surface.
6. Interspace Content: 1/2" VTS black spacer - Argon filled.
7. Silicone: Black
8. Indoor Lite: Heat-strengthened float glass, Pure Mid Iron.
9. Safety glazing required.

E. Glass Type GL-5: (GL-1 with Privacy Film).
1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
5. Coating: VNE-53 on #2 surface.
6. Interspace Content: 1/2" VTS black spacer - Argon filled.

7. Silicone: Black
8. Indoor Lite: Heat-strengthened float glass, Pure Mid Iron.
9. Safety glazing required.

F. Glass Type GL-6: (GL-1 with Meltdown **Glass at inner lite) (Add. A).**
1. Basis-of-Design Product: 1" VNE35-53 Insulating Glass as manufactured by Viracon. **Inner lite by MELTDOWN GLASS AT & DESIGN(Add. A)**
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Heat-strengthened float glass, Pure Mid Iron.
5. Coating: VNE-53 on #2 surface.
6. Interspace Content: 1/2" VTS black spacer - Argon filled.
7. Silicone: Black
8. Indoor Lite: Heat-strengthened float glass, **Low-iron, *MD SNOW*. (Add. A)**
9. Safety glazing required.

END OF SECTION

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and application of paint systems on the following exterior substrates:
   1. Concrete.
   2. Concrete masonry units (CMUs).
   3. Steel and iron.
   4. Galvanized metal.

1.2 DEFINITIONS

A. MPI Gloss Level 1 (Matte or Flat Finish): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3 (Eggshell Finish): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4 (Satin Finish): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5 (Semigloss Finish): 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6 (Gloss Finish): 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7 (High Gloss Finish): More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include preparation requirements and application instructions.
   2. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   3. Indicate VOC content.

B. Sustainable Design Submittals:
   1. Product Data: For paints and coatings, indicating VOC content.
   2. Environmental Product Declaration (EPD): For each product.
   3. Material Ingredient Documentation: For each product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system.

3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint: 5 percent, but not less than 1 gal. of each material, **gloss level,** and color applied. **(Add A)**

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
   a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
   b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
   a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain paint from single source from single manufacturer.

2.2 PAINT PRODUCTS

A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."
   1. Provide products from manufacturer's premium or professional product line.

B. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Environmental Product Declaration: Provide Type III Product Specific Environmental Product Declaration with external verification in which the manufacturer is recognized as the participant by the program operator in accordance with ISO 14025, and EN15804 or ISO 21930 and that have at least a cradle to gate scope.

D. Manufacturer Inventory: For each product, provide manufacturer's manifest that product does not contain intentionally added cadmium or lead.

E. VOC Content: For field applications, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 50 g/L.
   3. Dry-Fog Coatings: 150 g/L.
   4. Primers, Sealers, and Undercoaters: 100 g/L.
   5. Rust-Preventive Coatings: 100 g/L.
   6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
   7. Pretreatment Wash Primers: 420 g/L.

F. Colors: Match Architect's samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Masonry (CMUs): 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
   1. SSPC-SP 2.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
   3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
   4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

5. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed to view:
   a. Equipment, including panelboards and switch gear.
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage through the Contractor the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:
   1. High-Build Latex System MPI EXT 3.1L: Dry film thickness of not less than 10 mils.
      a. Prime Coat: As recommended in writing by topcoat manufacturer.
      b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
      c. Topcoat: Latex, exterior, high build, MPI #40.

B. CMU Substrates:
   1. High-Build Latex System MPI EXT 4.2K: Dry film thickness of not less than 10 mils.
      a. Prime Coat: As recommended in writing by topcoat manufacturer.
      b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
      c. Topcoat: Latex, exterior, high build, MPI #40.

C. Steel and Iron Substrates:
   1. Alkyd System MPI EXT 5.1Q:
      a. Alkyd Prime Coat: Primer, alkyd, anticorrosive, for metal, MPI #79.
      b. Shop Prime Coat: Shop primer specified in Section where substrate is specified.
      c. Surface-Tolerant Prime Coat: Primer, metal, surface tolerant, MPI #23.
      d. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
      e. Gloss Topcoat: Alkyd, exterior, gloss (MPI Gloss Level 6), MPI #9.

D. Galvanized-Metal Substrates:
   1. Alkyd System MPI EXT 5.3B:
      a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
      b. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
      c. Gloss Topcoat: Alkyd, exterior, gloss (MPI Gloss Level 6), MPI #9.

END OF SECTION

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete.
   2. Concrete masonry units (CMUs).
   3. Steel and iron.
   4. Galvanized metal.
   5. Gypsum board.
   6. Cotton or canvas insulation covering.
   7. ASJ insulation covering.

1.2 DEFINITIONS

A. MPI Gloss Level 1 (Matte or Flat Finish): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2 (Velvet Finish): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3 (Eggshell Finish): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4 (Satin Finish): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5 (Semigloss Finish): 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6 (Gloss Finish): 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7 (High Gloss Finish): More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Sustainable Design Submittals:
   1. Product Data: For paints and coatings, indicating VOC content.
   2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

3. Environmental Product Declaration: For each product.
4. Material Ingredient Documentation: For each product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint: 5 percent, but not less than 1 gal. of each material, **gloss level** and color applied.
2. **Provide maximum of 10 gallons.**
3. **Provide in containers not greater than 1 gallon capacity. (Add A)**

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems indicated to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
   1. Provide products from manufacturer's premium or professional product line.

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Environmental Product Declaration: Provide Type III Product Specific Environmental Product Declaration with external verification in which the manufacturer is recognized as the participant by the program operator in accordance with ISO 14025, and EN15804 or ISO 21930 and that have at least a cradle to gate scope.

D. Material Ingredients: Documentation that demonstrates the chemical inventory of the product to at least 0.1 percent (1000 ppm).

E. Manufacturer Inventory: For each product, provide manufacturer's manifest that product does not contain intentionally added cadmium or lead.

F. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 50 g/L.
   3. Dry-Fog Coatings: 150 g/L.
   4. Primers, Sealers, and Undercoaters: 100 g/L.
   5. Rust-Preventive Coatings: 100 g/L.
   6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
   7. Pretreatment Wash Primers: 420 g/L.

G. Low-Emitting Materials: Paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Colors: Match Architect's samples.
   1. Items Not Included in Finish Schedule: As selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Masonry (CMUs): 12 percent.
   3. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
1. SSPC-SP 3.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
6. Paint latex sealants color as directed by Architect.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.

c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.
h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:
a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIRE-RATED AND SMOKE CONTAINMENT ASSEMBLIES

A. Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling. Such identification shall:
1. Be located in accessible concealed floor, floor-ceiling or attic spaces; and
2. Be located within 15 feet of each end of each wall and repeated at intervals not exceeding 30 feet measured horizontally along both sides of the wall or partition; and
3. Include lettering not less than 3 inches in height, incorporating the suggested wording: " FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS" or other wording approved or required by AHJ (Authority Having Jurisdiction).
4. Apply a minimum one-inch wide bright red horizontal line, both sides of wall, interrupted for approved text, at the required interval.

3.5 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage through the Contractor the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.6 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:
   1. High-Performance Architectural Latex System, MPI INT 3.1C:
      a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
      b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
      c. Topcoat: Latex, interior, high performance architectural, satin (MPI Gloss Level 4), MPI #140.

B. CMU Substrates:
   1. High-Performance Architectural Latex System, MPI INT 4.2P:
      a. Block Filler: Latex, interior/exterior, MPI #4.
      b. Prime Coat: Primer, alkali resistant, water based, MPI #3.
      c. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
      d. Topcoat: Latex, interior, high performance architectural, satin (MPI Gloss Level 4), MPI #140.

C. Steel Substrates:
   1. High-Performance Architectural Latex System, MPI INT 5.1RR:
      a. Prime Coat: Primer, alkyd, anticorrosive, for metal, MPI #79.
      b. Prime Coat: Shop primer specified in Section where substrate is specified.
      c. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
      d. Topcoat: Latex, interior, high performance architectural, semigloss (MPI Gloss Level 5), MPI #141.

D. Galvanized-Metal Substrates:
   1. High-Performance Architectural Latex System, MPI INT 5.3M:
      a. Prime Coat: Primer, galvanized, water based, MPI #134.
      b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
      c. Topcoat: Latex, interior, high performance architectural, semigloss (MPI Gloss Level 5), MPI #141.

E. Gypsum Board Substrates:
   1. High-Performance Architectural Latex System, MPI INT 9.2B:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, eggshell (MPI Gloss Level 3), MPI #139.
d. Topcoat: Latex, interior, high performance architectural, satin (MPI Gloss Level 4), MPI #140.

F. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.
1. Institutional Low-Odor/VOC Latex System, MPI INT 10.1D:
a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.

END OF SECTION

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Special Conditions, apply to this Section.

B. Architectural Barriers Act (ABA) Accessibility Guidelines.

C. Indian Health Service (IHS) guidelines and standards for hospital signage.

1.2 SUMMARY OF WORK INCLUDED

A. CONTRACTOR shall be responsible for securing all sign permits, including payment of fees, required by White Mountain Apache Tribe and all other local agencies. for the installation of all exterior and interior signage for the Project.

B. Sign Fabrication: Types of signs, messages, and graphics are indicated on the drawings and herein, and require various materials, finishes, illumination and fabrication and installation techniques.

C. Shop drawings, layouts, samples, and mock-ups for Indian Health Service (IHS) approval.

D. Installation of all fabricated signs, including all fasteners and fastenings and related electrical and data connections.

E. Coordination with all trades of this Contract required for the fabrication and installation of the signage, including the approvals by the IHS required in this Section. Fabrication and installation of the Work in accordance with National Electrical Code (NEC); latest edition, Underwriters Laboratory UL); latest edition, National Fire Protection Agency (NFPA); latest edition and National Electrical Manufacturers Association Standards.

F. Coordination and verification of all messages with IHS. Sign contractor to provide complete sign message and graphic layouts for review and approval by Design teams and IHS.

G. Verification of all conditions and sign dimensions in the field. Sign Fabricator to coordinate all signage requirements with the architectural, structural, lighting, electrical, civil, landscape, life safety, and telecommunications drawings to ensure that all proposed signs can be installed, with power and required data connections and structurally supported. Verification of conditions and sign dimensions to be completed prior to sign fabrication and approval of all required submittals.

H. Sign Types and Quantities

I. The Sign Fabricator is responsible for verifying quantities with the IHS and DESIGNER.

1.3 DESIGN CRITERIA

A. SHOP DRAWINGS

The Contract Drawings provided may communicate general basis of design or fabrication expectation to achieve design intention purposes but do not constitute fabrication or shop drawings. It is the responsibility of the Signage Contractor to develop and submit all details necessary to clearly communicate and define the

fabrication process, as well as the expected performance of the installed product. The Signage Contractor must demonstrate a thorough understanding of the intended final product through comprehensive details and product specification, including the methods and processes to be used in its production. Field verification and measurement are required prior to the submission of shop drawings. Repackaging the provided Contract Drawings with new title blocks and submitting them as shop drawings will not be accepted. While electronic artwork may be provided, the Signage Contractor must be prepared to create all graphic content from scratch, as needed, to verify and ensure the quality and accuracy of the final delivered product. Signage Contractor to verify final artwork dimensions comply with any federal or local regulations. Provide complete fabrication and installation shop drawings for each sign type. Drawings shall include all relevant information, including dimensions, materials, finishes, fastening methods, anchorage details, joints and visible seams, sealing methods, backing materials, utility requirements, rough-in conditions, and adjacent site conditions related to the installation.

B. The Architectural Graphics Drawings represent the design intent for the signs required for the Project. The Sign Fabricator is responsible for the proper engineering of all elements of the Work and where applicable. The internal structure, dimensions, and specifications for all items shall be indicated in the shop drawings. The Signage Contractor shall be responsible for the structural design and calculations for all ceiling-suspended, floor-mounted, projected signage, wall-mounted signs (weighing more than 5lbs.), and ground-mounted signage, including the provision of engineered foundation/footer to ensure the structural integrity of all support connections. Wind load calculations shall be provided for all exterior signage, or where otherwise applicable, in accordance with governing building codes and project requirements. All structural connections and calculations must be performed by and certified by a Professional Engineer licensed in the State of Nevada. Submit all stamped drawings for Designer and Owner’s review and record.

C. Provide shop drawings for all items including, but not limited to the following:
   1. Complete fabrication and installation drawings for each sign type. Indicate dimensions, materials, finishes, fastening, anchorage, joining, sealing, backing, utility requirements, rough-in, and adjacent related site conditions.
   2. Each sign type with all graphic elements.
   3. Evacuation Map final graphics. The Designer will provide a clean evac map template for each level to be used for developing specific area plans and routes as coordinated with the local fire department representative and Emergency Egress plans during the early phases of Construction Administration. Fabricator to develop individual evac maps for all locations based on the templates. Include all fire alarms, fire pull, address, alarm sound, current level info, correctly oriented north symbol, fire extinguisher, and exit route locations on the maps, as required. Review fire life safety plans as required to verify equipment locations. Coordinate with AHJ (Authority Having Jurisdiction) or fire department as required. Include all maps in the shop drawings for review. Ensure the maps are oriented correctly based on each sign location.
   4. The Signage Contractor shall be responsible for coordinating and verifying all sign messages with the Designer. The Designer shall provide a complete set of sign

location plans, including a sample sign numbering system and a message schedule in table format. The Signage Contractor shall use the message schedule to prepare complete visual sign message layouts for review and approval by the Designer and/or Owner. These visual layouts shall be used to verify final messages, ensure graphic accuracy, and confirm proper typography. Multiple revisions should be anticipated to finalize all messages.

5. All final as-built drawings shall be provided by the Sign Fabricator as part of the project closeout procedures. These drawings shall include all commentary obtained during the project, including RFI responses, sample reviews, shop drawing reviews, and mockup reviews—reflecting all installed locations, conditions, and final quantities.
6. All letter styles shall be accurately reproduced.
7. Connections and routing for all power and data cabling.
8. Braille message coordinated with corresponding raised characters.

1.4 SUBMITTALS

A. Procedure: Prepare submittals in accordance with the Contract Drawings requirements and to include the following:
   1. Notes on Drawings shall clearly define any actions requiring review by the IHS.
   2. First article of production-run items, both large and small, will be reviewed by IHS before production run is commenced.
   3. It shall be the responsibility of the Contractor to schedule all review meetings with IHS.

B. Submit physical samples of sufficient size and quantity to illustrate materials, finishes, equipment, or workmanship, and to establish standards by which completed work will be judged. Samples must represent the functional characteristics of the product or material, with integrally related parts and attachment devices, colors, and finishes.

C. All samples to have a place for stamp approval.

D. Required samples for review:
   1. Full 4" x 4" set of all specified paint colors and finishes.
   2. Complete, scaled, message layout for each sign face, to demonstrate proper spacing and content (black text on white background: outline not accepted).
   3. Sample of each type of fastener to be used.
   4. Each type of exposed metal used for major elements of work with respective finish.
   5. Each type of adhesive vinyl film, including computer-cut designs, shown full-size on each of the specified ground colors.
   6. Mock-ups as scheduled in this section. Mock-ups shall become the property of IHS and are not to be part of the completed work.
   7. Unless otherwise noted, one full size, complete, item must be prepared and installed by the fabricator as “first article” for each sign type. Upon inspection and approval by the IHS, the fabrication of subsequent articles may continue.
   8. Other items as may be required by IHS, or as noted on the Drawings or herein.

E. Extra Materials / Spares: Deliver to the appropriate IHS Representative contact person, in manufacturer’s original packaging and store at the Project where directed.
   1. Furnish (1) gallon of each finish paint color for touch-up purposes.

2. Furnish (6) lamps of each type and size used in the signage (as applicable).
3. Furnish spare keys to master keyed locks on directory or Kiosk signage.

F. Supplementary Product Literature: Submit for information. Furnish within seven (7) days of request, manufacturer's literature describing the general properties of each product to be used in the work.

1.5 PERMITS BY SIGNAGE CONTRACTOR

A. Signage Contractor shall be responsible for paying all fees, making adjustments as required, or any task necessary for obtaining local building and installation Sign permits for the proper execution of the Work.

1.6 QUALITY ASSURANCE

A. Mock-ups and Prototypes:
1. Provide a mock-up for each sign type as indicated in Section 1.06 and the Contract Drawings. Mock-ups may be full-size signs or approved partial sections and must be fabricated at full scale (1:1) unless otherwise coordinated with the Owner and Designer. When a full-size mock-up is not feasible, an alternative scale or partial mock-up may be used if it meets the design intent and is approved by the Designer.
2. Mock-ups must use the same materials, construction, and installation methods intended for the final Work. Schedule installation to allow adequate time for review and required adjustments before proceeding with fabrication. Unsatisfactory mock-ups must be replaced as directed.
3. For freestanding signs, demonstrate the proposed mounting method, including stability, level placement, concealed attachments, and supporting structural calculations.
4. Once approved by the Designer and Architect, the mock-up becomes the standard for materials, workmanship, and appearance. Approved mock-ups may serve as First Articles, and in some cases—with Designer approval—a single mock-up may be used to review multiple sign types with similar styles or designs. Reviewed and approved mock-ups may also be used for final installation when permitted by the Owner.

B. Work-In-Progress Approvals:
1. Provide work-in-progress sign elements reviews. Scheduled or unscheduled viewings at the Fabrication Facility may be initiated by the IHS Representative as deemed necessary to ensure continued quality control and make any adjustments required during fabrication. Unsatisfactory items are to be corrected by the Signage Contractor as directed by IHS.

C. Regulatory Requirements:
1. Comply with applicable requirements of the Applicable Laws and Authorities. Obtain necessary approvals and permits from Authorities as required.

D. Markings and Labels:
1. All markings, labels, manufacturer names, and other identifying information must be located and concealed from public view. Concealment methods must be acceptable to the IHS Representative and comply with applicable standards.

2. No trade name or other identification shall appear on any item where it will be seen by the public, except as specifically approved by IHS Representative in advance.

E. Final Location of Signs:
1. The location of signs as shown on the Location Plans is for general reference only and in some cases is not representative of the exact final location. Final locations of Signs shall be field located in coordination with IHS.
2. Signage Contractor shall arrange for meetings at the Project to accommodate direction of final locations according to Project Construction Schedule.

F. Lettering:
1. The Signage Contractor shall be responsible for the quality control of all lettering. All letterforms shall be crisp, sharp, free of nicks, ragged edges, and discontinuous curves. All lettering shall conform to approved typeface, weight and letter spacing. No substitutions of typeface foundry, brand or version or implementation technique will be accepted without prior approval.
2. Vinyl Die Cut Graphics: All vinyl artwork shall be digitized to a vector format to allow for digital cutting fabrication.
3. All cutting and routing shall be executed in such a manner that all edges and corners of finished letterforms are true and clean. Letterforms with rounded positive or negative corners, nicked, cut, or ragged edges, etc., will not be accepted. All letterforms shall be so aligned as to maintain a baseline parallel to the sign format. Margins must be maintained as specified in drawings.
4. All Work under the Agreement shall be performed by skilled craftsmen under supervision of trained foremen, experienced in the trade of craft required to accomplish the Work and produce a product of high quality.

G. Tactile sign messages:
1. All tactile sign messages must comply with ABA guidelines, Chapter 7: Communication Elements and Features, Tactile Signs.
2. Character spacing shall be measured between the two closest points of adjacent raised characters within a message, excluding word spaces. Where characters have rectangular cross sections, spacing between individual raised characters shall be 1/8-inch (3.2 mm) minimum and 4 times the raised character stroke width maximum. Where characters have other cross sections, spacing between individual raised characters shall be 1/16 inch (1.6 mm) minimum and 4 times the raised character stroke width maximum at the base of the cross sections, and 1/8 inch (3.2 mm) minimum and 4 times the raised character stroke width maximum at the top of the cross sections. Characters shall be separated from raised borders and decorative elements 3/8-inch (9.5 mm) minimum.
3. Braille shall be contracted Braille (Grade 2), domed compliant with Arizona Building Code, and maintain a minimum 3/8 inch clear-space from other tactile elements.
4. Proof-reading of Braille messages is to be performed by the sign fabricator prior to fabrication.

H. High quality of workmanship:
   1. The Signage Contractor shall be responsible for the high quality of all materials and workmanship required for the execution of the Agreement including materials and workmanship of any firm or individual who act as Signage Contractor's Sub-Contractor.

I. Dimensions:
   1. Written dimensions on drawings shall have precedence over scaled dimensions.
   2. Signage Contractor shall verify and be responsible for all dimensions and conditions shown by these drawings. Shop details must be approved by IHS prior to fabrication.

J. Discrepancies
   1. Signage Contractor shall notify IHS of any discrepancies in the Drawings, Sign Location Plan or Sign Message Schedule, in field dimensions or conditions and/or changes required in construction details.

K. Regulatory Requirements:
   1. Comply with applicable portions in current ABA Standards.
   2. References
      a. Arizona Building Code/ Arizona Fire Code
      b. Arizona Public Safety Codes
      c. Arizona Environmental Protection Codes
      d. National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual."
      e. American Welding Society (AWS) – AWS D1.1 "Structural Welding Code, Steel," and AWS D1.2 "Structural Welding Code, Aluminum."
      f. Underwriters Laboratories Inc. (UL) – Standards for Safety, UL Publication 48 "Electric Signs."

1.7 GRAPHICS/ARTWORK

A. IHS to provide artwork via electronic file transfer; Adobe Illustrator, Acrobat PDF, MAC Format for graphic layouts included in the Drawings.

1.8 WARRANTY

A. Signage Warranty
   1. Submit to IHS a 5-year written warranty (effective the date of final acceptance) covering all Signs, by the Signage Contractor and Installer (if Sub-Contractor is used), agreeing to repair or replace the Defective Signs. Upon notification of such Defective Signs within the warranty period, make necessary repairs or replacement at the convenience of IHS.

B. Linear Polyurethane Paint Factory Finish Warranty
   1. Submit to IHS a 5-year written warranty, warranting that the factory-applied linear polyurethane finishes will not develop excessive fading or excessive non uniformity of color or shade, and will not crack, peel, pit, corrode or otherwise fail as a result of Defects in materials or workmanship within the following defined limits. Upon notification of such Defects within the Warranty Period, make necessary repairs or replacement at the convenience of the IHS.

C. "Excessive Fading"
   1. A change in appearance that is perceptible and objectionable as determined when visually compared with the original color range standards.

D. "Excessive Non-Uniformity"
   1. Non-uniform fading to the extent that adjacent panels have a color difference greater than the original acceptable range of color.

E. "Will Not Pit or Otherwise Corrode"
   1. No pitting or other type of corrosion, discernible from a distance of 10' (3 m), resulting from the natural elements in the atmosphere at the project site.

1.9 MAINTENANCE

A. Maintenance and Operating Manuals
   1. Provide Maintenance and Operating Manuals to IHS per SECTION 017823 – OPERATION AND MAINTENANCE DATE.
   2. Furnish complete manuals describing the materials, devices and procedures to be followed in operating, cleaning and maintaining the Work. Include manufacturers' brochures and parts lists describing the actual materials used in the Work, including metal alloys, finishes, electrical components and other major components.
   3. Assemble manuals for component parts into single binders identified for each system.

B. Instruction
   1. Prior to acceptance, establish with IHS an instruction and training program for IHS personnel.
   2. Notify the IHS in writing at least 7 days prior to commencement of the program providing an outline of topics indexed to the Maintenance and Operating Manual.
   3. Provide a trained instructor. Provide three (3) consecutive 4-hour periods of training scheduled during the normal 8-hour working day. Instruction and training shall include, but shall not be limited to, procedures to be followed in the normal day-today maintenance and operation of the Work.

PART 2 - PRODUCTS

2.1 FABRICATION

A. Signage shall be complete for proper installation as described in the Drawings.

B. Finish work shall be firm, well anchored, in true alignment, properly squared, with smooth clean uniform appearance, without holes, cracks, discoloration, distortion, stains, or marks.

C. Construct all work to eliminate burrs, dents, cutting edges, and sharp corners.

D. Finish welds on exposed surfaces to be imperceptible in the finished work.

E. Except as indicated or directed otherwise, finish all surfaces smooth.

F. Surfaces, which are intended to be flat, shall be without dents, bulges, oil canning, gaps, or other physical deformities.

G. Surfaces, which are intended to be curved, shall be smoothly free flowing to required shapes.

H. Except where approved otherwise by IHS Authority, conceal all fasteners.

I. Make access panels tight-fitting, light proof, and flush with adjacent surfaces.

J. Conceal all identification labels and Underwriters Limited labels to conform to Underwriters Limited Codes.

K. Carefully follow manufacturer's recommended fabricating procedures regarding expansion or contraction, fastening, and restraining of acrylic plastic.

L. Exercise care to ensure that painted, polished, and plated surfaces are unblemished in the finished work.

M. Isolate dissimilar materials. Exercise particular care to isolate nonferrous metals from ferrous metals.

N. All illumination shall be even and without hot spots.

O. Ease all exposed metal edges.

P. Provide miscellaneous metal items required for completion of the work even though not shown or specified.

Q. Refer to Drawings for sign color specifications.

R. Paint finishes shall be Matthews Acrylic Polyurethane with Matthews Primers and Metal Pre-Treatments or IHS approved equal.

S. Shop painting to be uniform on and around all sign elements to ensure sign elements will withstand all weather conditions.

T. Mounting: Mounting plates shall be in conformance with manufacturer's written recommendations.

2.2 MATERIALS

A. All Specified Metals
   1. Aluminum
      a. Aluminum shall be suitable for ornamental, architectural work. Surface finish shall be smooth, free of extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of the specific application.
   2. Stainless Steel
      a. Stainless steel shall be suitable for ornamental and architectural work. Surface finish shall be smooth, free of all extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of specific application. Structural metal for concealed framing shall be of galvanized rolled steel or equal as required to satisfy structural requirements.

B. Aluminum exterior cabinets, spacers, backplates and frames shall be constructed from 0.25 inch aluminum, #4 horizontal brushed and clear anodized finish, unless otherwise specified on Drawings.

C. Aluminum interior plaques shall be constructed from 0.125 inch aluminum, #4 horizontal brushed finish with semi-gloss linear polyurethane clear coat, unless otherwise specified on Drawings.

D. Aluminum interior fabricated components shall be constructed from 0.125 inch thickness aluminum sheet.

E. Adhesive used for installing Signs shall be manufactured by Dow Corning or equal. “VHB” tape such as Polyfoam or “Isotac” contact adhesive tape manufactured by 3M shall be used available.

F. Extruded aluminum shapes utilizing 6063-T6 aluminum alloys, unless otherwise specified on Drawings.

G. Concrete Installation of anchoring devices into concrete slab shall be adjusted to avoid penetrating existing reinforcing conduit, etc. contained in the concrete slab. Coordinate with the Architect and Structural Engineer.

H. Stainless steel exterior cabinets, spacers, backplates and frames shall be constructed from 0.125 inch stainless steel, #4 horizontal brushed and clear anodized finish, unless otherwise specified on Drawings.

I. Stainless steel interior plaques shall be constructed from 0.125 inch thickness stainless steel sheet, #4 horizontal brushed finish with semi-gloss linear polyurethane clear coat, unless otherwise specified on Drawings.

J. Stainless steel interior fabricated components shall be constructed from 0.0625 inch stainless steel, unless otherwise specified on Drawings.

K. Stainless steel shall be suitable for ornamental and architectural work. Surface finish shall be smooth, free of all extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of specific application. Structural metal for concealed framing shall be of galvanized rolled steel or equal as required to satisfy structural requirements.

L. Acrylic intended for non-illuminated use shall be 0.25 inch cast acrylic sheet with non-glare finish, unless otherwise specified on Drawings. Acrylic intended for edge-illuminated use shall be 10mm extruded acrylic sheet with embedded diffuser particles designed specifically for edge-lighting, unless otherwise specified on Drawings.

M. Use Plexiglas II as manufactured by Röhm GmbH, or equal quality. Thickness shall be as indicated on Drawings or not less than 1/8" thick. Signage Contractor shall provide color and finish samples of all plastics for approval before fabrication; no substitution in color, thickness, or finish of plastics will be accepted without written approval from the IHS. All plastics shall be of uniform color, translucence and illumination, as supplied by manufacturer. Any exposed edges of acrylic shall be finished so as no saw marks are visible.

N. Decal or Transfer: Provide special printed paper or vinyl suitable for reproducing the design onto material indicated, as required. Submit sample to the IHS for approval.

O. Aluminum posts shall be constructed from 2-inch square T52 tubes, 0.1875 wall thickness and #4 brushed and clear anodized finish with capped ends, unless otherwise specified on Drawings.

P. Hardware / Hinges: Provide and install all incidental hardware necessary for the proper functioning of the Signs, including, but not restricted to, materials and products covered in this section. Provide stainless steel hinges for all hinged access panels. Provide pin

tumbler locks for all access panels requiring locks. Provide stainless steel fasteners for assembling ferrous and non-ferrous metals.

Q. Bolts, nuts, screws, washers, anchors and other devices required to complete the Work. Signage Contractor shall use the same basic metal or alloy as the metal fastened, and finish to match in color and texture. Use stainless steel 300 series alloy where used to join dissimilar materials.

R. All exposed fasteners to be 0.125 inch flathead stainless steel screws painted to match adjoining surfaces unless otherwise specified on drawings.

S. Pin-mount supports shall be 3/16” to 1” diameter painted threaded rods as appropriate.

T. Insulation /Material Isolation: Separate all ferrous and non-ferrous metals with non-conductive gaskets to prevent electrolysis. In addition to gaskets, provide stainless steel fasteners for some cases as required.

U. Welding Electrodes and Filler Metal
   1. Provide the alloy and type of welding electrodes and filler metal required for strength, workability, compatibility and color match after grinding smooth and finishing the fabricated product.

V. Applied interior vinyl graphics to be High Performance Cast Vinyl Sheeting, unless otherwise specified on Drawings. Applied exterior vinyl graphics to be High Performance Reflective Vinyl Sheeting, unless otherwise specified on Drawings.

W. Additional Material/Processes: For materials or processes described in the preceding list, the material and/or process as detailed in the design documents shall be used as the meet or exceed equivalent.

2.3 ELECTRICAL COMPONENTS

A. Electrical components must conform to applicable electrical codes and the following:
   1. All materials must be approved and listed by Underwriters Laboratories, Inc.
   2. Light Emitting Diode (LED) general lighting requirements:
      a. Provide sufficient LED wattage, quantities and spacing to ensure continuous, maximum illumination.
      b. Provide LED lighting prototypes to verify brightness and uniformity of lighting with designer.
   3. LED lighting component, color, and power requirements:
      a. Edge lighting – fabricated linear white LED’s 24 VAC
      b. Back lighting – fabricated matrix white LED’s 24 VAC
   4. Heavy duty, non-keyed, flush mounted, fused, or un-fused disconnects. Provide NEMA 1 for dry locations and proper enclosure for others.

B. Electrical Wiring and Equipment: Provide and install electrical materials such as ballasts, transformers, lamps, sockets, neon units, connectors, and all other equipment which shall be new and shall be approved by Underwriters Laboratories, Inc. The assembly of all components within the illuminated signs shall conform to all standards of Underwriters Laboratories, Inc. as published in the latest edition of “Standards for Sign Safety” and all illuminated signs shall bear the U.L. label. All wiring and equipment shall be concealed within the Sign structure.

C. Conduit and Devices: Provide rigid steel conduit, junction boxes and associated devices in accordance with applicable codes as required.

D. Wiring: Minimum #12 AWG copper shall be used. High tension wiring shall not be less than GTO 15 wire as manufactured by Carol Cable Company or approved equal. All wiring shall be AWM 90 0 centigrade 1000 volt TW/MTW U.L. file no. 18971. Wiring connectors for wire splicing shall be U.L. approved 1000 volt capacity and shall be Scotch Lock type Y or R or equal. All splices should be easily accessible for inspection and should be shown on Shop Drawings.

E. Disconnect Switch: All Signs or Sign components with electrical service shall be equipped with an approved external disconnect switch, flush mounted on the cabinet / Sign, with circuits and capacity to control all primary wiring within the Sign. Location of switch must be shown on Shop Drawings and is subject to approval.

F. Illumination: All signs with LED fixtures shall provide even, diffused, illumination without light leaks or hotspots. Signage Contractor shall provide any specification information required to verify performance. All fixtures shall be provided by the Signage Contractor. Signage Contractor shall provide waterproof flush access panel(s), which shall be concealed wherever possible. Conduit wiring and electrical equipment from the field electrical connection to any part of the sign and within the sign shall be provided by the Signage Contractor.

G. Ventilation: While maintaining a proper weather seal, Signage Contractor shall provide for sufficient ventilation of Sign components to prevent overheating or warping; allowing for color of sign, mounting surface, climate conditions, etc. In providing for ventilation, Signage Contractor shall protect sign from elements (rain, wind, debris, etc.) that might cause operational or cleaning problems. Signs / cabinets with light leaks will not be accepted. Signage Contractor shall utilize stainless steel bug mesh screen for integration with weep holes or vent / louvers on the Signs to prevent insect migration into illuminated Signs.

H. Exterior LED Display: Electronic Full Color LED Video Displays shall be Optec Displays Model: **INF-MOD-6.6HB2-RGB-V-S-D / Infinity High Brightness HB2 SMD 6.6mm Full Color** or equal. Electronic Full Color LED Video Displays MUST conform to FCC Title 47, Part 15, Class A. The LED displays MUST have the FCC Compliance statement sticker affixed to the exterior of the product. Upon request, LED display manufacturer MUST provide an accredited Third-party Testing Lab Certificate of Compliance for the LED display model quoted for this project. The LED displays MUST showcase the following statement on the exterior of the LED displays, as required by 47 CFR Section 15.19(a)(3): “This device complies with part 15 of the FCC Rules. Operation is subject to the following two Conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.”

1. Electronic LED Video Display Specifications: Electronic LED Video Displays MUST meet or exceed the minimum specifications described below.
    a. Optec Model **Infinity INF-MOD-6.6HB2-RGB-V-S-D / Infinity High Brightness HB2 SMD 6.6mm Full Color** or approved equal.
    b. Pixel Pitch (Pixel Spacing): Center-to-Center pixel spacing MUST not exceed **6.6 mm (0.26 inch) TRUE pixel pitch (Not Virtual pixel pitch).**

c. Pixel Configuration / Technology: Each pixel MUST be **SMD (3-in-1 LEDs) type TRUE pixel (No virtual or pixel sharing). Each SMD pixel has 1 Red, 1 Green and 1 Blue LEDs.**

d. Pixel Matrix: Each LED display MUST be no less than **180 pixels (High) x 288 pixels (Wide)**.

e. Colors: RGB 281 Trillion Levels.

f. Color Processing: 16-Bit grayscale color processing.

g. Video Frame Rate: 60 FPS. The display shall have 60 Frames per Second Video Frame Rate for smooth full motion video playback.

h. Refresh Rate: ± 3840 Hz (Adjustable) for optimized viewing experience.

i. Brightness: Maximum Brightness MUST NOT be less than 9,500 NITs. Color-Calibrated, White-Balanced Brightness MUST NOT be less than 8,000 NITs. (Add A)

j. Cabinet Design: LED display MUST be an Edge-to-Edge display. The display shall not have any borders. Pixels and LEDs MUST go all the way to the edges to utilize the entire available space for showing content. The cabinet size MUST be same as the actual viewing area or active display area.

2.4 TEMPORARY SIGNAGE

A. Moveable Concrete Sign Base: Provide the following, or other products as acceptable.

1. Telespar Concrete Sign Bases: Unistrut Midwest or approved equal, concrete sign bases with Unistrut Telespar galvanized sleeve and post integration. 2-inch 10 or 12 gauge. Perforated holes 7⁄16" spaced on 1" centers. Provide zinc-electroplated fittings, fasteners and accessories for splicing, extending and reinforcing.

2.5 FINISHING MATERIALS

A. Linear Polyurethane Coatings: Provide the following, or other products as acceptable.

1. Acrylic Linear Polyurethane enamel: Two components, acrylic aliphatic isocyanate /acrylic polyurethane having ultraviolet (UV) inhibitors and engineered for exterior application by Matthews Paint Company or approved equal.
2. Primer for Aluminum: Two-part component primer: One-coat Matthews 74-734 and 74-735 Metal Pretreat at. 25 mils dry film thickness or one-coat Matthews 74-793 Spray Bond at .15 to .25 mils dry film thickness or Wyandotte / AKZO Grip-Guard Wash Primer (2Afy-31284) with Grip-Guard Wash Primer Hardener (10AFK-31285) combined and applied per manufacturer’s specifications or approved equal (primer) for the application of the pre-approved and pre-formulated paint system.
3. Primer for Steel: Two-part component primer: One-coat Matthews 74-734 and 74-735 Metal Pretreat at .25 mils dry film thickness or Wyandotte / AKZO Grip-Guard Wash Primer (2Afy-31284) with Grip-Guard Wash Primer Hardener (10AFK-31285) combined and applied per manufacturer’s specifications or approved equal (primer) for the application of the pre- approved and pre-formulated paint system.

4. Clear Sealers: Crystal clear matte polyurethane sealers By Matthews Paint Co. or approved equal. Sealers are to resist rust and corrosion associated with exposure to salt air. As required and of highest quality available, applied per manufacturer's specifications.

B. Anodized Aluminum Components / Panels: If required, Signage Contractor shall provide anodized (application of aluminum oxide film coating in clear or colored dye finish) aluminum panels or parts to match Executive Architect's color, grain, finish, and specifications.

C. Silk Screening Materials: Provide photo processed screening, arranged to furnish sharp and solid images without edge build up or bleeding of the coating. Pattern-cut screens may be used for non-repeat copy, provided that final image copy is equal to photoscreen quality. Provide only weather-resistant coating materials, compatible with the intended substrates. All silk-screened graphics are to be done with the finest screen size feasible for sharp, even reproduction.

D. Vinyl Die-Cut and Pattern Cut-out Graphics: Use Scotchcal Opaque and Translucent film and Scotchcal Diamond Grade VIP Reflective film manufactured by 3M where specified. Use pressure-sensitive, non-yellowing, non-peeling and weather resistant vinyl as specified. Use approved fonts and equipment as specified.

2.6 FABRICATION OF SIGNS AND SUPPORTS

A. General: Provide custom manufactured Sign assemblies, components completely fabricated and finished at factory before delivery to Project. Construct to accurate detail and dimensions as shown and as review on approved Shop Drawings. Fit and assemble the Work at the shop and mark the components as required to facilitate assembly during installation. Exposed fasteners on finished faces will not be allowed, unless specifically indicated. Waviness and oil canning of surfaces is not acceptable. Minimum material thickness is to be 0.090 inches. Conceal wiring, conduct and other electrical items within sign enclosures.

B. Lettering: Cut and rout in a manner to produce true and clean edges and corners of finished letterforms. Letterforms having rounded positive or negative corners, nicked, cut, or ragged edges are not acceptable. Align letter forms to maintain a baseline parallel to the sign format. Maintain margins as indicated on the Drawings.

C. Seams and Joints: The Signage Contractor shall cut walls and floors carefully and neatly repair them in an acceptable manner. Signage Contractor shall consult the Architect of Record in cases where cutting into a structural portion of the building is required so that satisfactory reinforcement may be provided. Added joints shall be ground filled and finished flush and smooth with adjacent work. Such seams shall be invisible after final finish has been applied. Spot welded joints shall not be visible on exterior of signs after final finish has been applied. No gaps, light leaks, waves, or oil canning will be permitted in Work. If any of these are evident, the Signage Contractor will be required to correct its Work or construct a new Sign at its own expense.

D. Metal Signs and Supports: Fabricate exposed surfaces uniformly flat and smooth, without distortion, pitting, or other blemishes. Form exposed metal edges to a smooth radius. Permanently bond the laminated metal components and honeycomb core with

adhesive or sealant in accordance with product manufacturer's recommendations. Grind exposed welds and rough areas to make flush with adjacent smooth surfaces.

E. Welding: Make welds continuous. Comply with American Welding Society, Aluminum Association, and Copper Development Association standards for the type of metal used.

F. Fasteners: Use exposed fasteners only if shown on the Construction Documents. Perform drilling and tapping at shop.

G. Dissimilar Materials: Where metal surfaces will be in contact with dissimilar materials, coat the surfaces with epoxy paint or plate with zinc chromate, or provide other means of dielectric separation as recommended by manufacturer to prevent galvanic corrosion (i.e. Neoprene gasket as an isolation membrane)

H. Castings: Exposed surfaces shall be uniformly free from porosity and roughness. Edges shall be filled and ground smooth. Faces shall be chemically etched and mechanically polished for specified finish.

I. Galvanizing: Provide for steel components in exterior construction, and where noted in Drawings shall be galvanized. Complete the shop fabrication prior to application of the zinc coating. Remove mill scale and rust, clean and pickle the units as required for proper pretreatment of the surfaces.

J. Hardware: Provide all incidental hardware necessary for the proper functioning of signs. External hardware shall conform to the external appearance of the Sign.

K. Supports and Backing in Walls: Signage Contractor shall provide engineered Sign supports anchored to building structure where required and to meet requirements of applicable building codes. Support or backing requiring installation within the building wall construction shall be immediately relayed to the Architect of Record and IHS for field coordination. Signage Contractor shall meet with the Contractor to review all requirements

L. Access Doors and Frames: Access doors and frames shall be flush with the material in which they occur, unless otherwise specified. Access doors and frames shall be provided upon prior written approval of the Architect. Each trade providing access doors and frames shall verify the need for fire rated doors on the Construction Drawings. Access doors in walls, partitions or ceilings shall bear UL fire rated labels of same fire rating. If access doors and frames are required to be exposed to view, they shall be chrome, brass, stainless steel, or other finish to match other finishes in the spaces in which they are to be installed, unless otherwise specified. Obtain IHS approval for location of each access door prior to placement.

2.7 SHOP APPLICATION OF SIGN FINISHES

A. Sign Graphics: Provide the letters, numerals, symbols, and other graphics markings, using the finish materials shown. Apply the graphics neatly, uniformly proportioned and spaced, and accurate within the dimensions indicated. Prepare the substrate surfaces and apply finish materials in accordance with manufacturers' instructions.

B. Metal Finishes: Remove scratches, abrasions, dents, and other blemishes before applying finish. Apply the following to the fabricated Work, with texture and reflectivity as required to match the Architect's sample.

C. Linear Polyurethane Finishes: Clean the surfaces as required for proper adhesion of coatings. Use 3M Co. “Scotch Brite” pads with cleanser and water, and/or chemically treat as recommended by paint manufacturer to remove deleterious film or residue.

D. Linear Polyurethane Paint: Provide pretreatment and primer in accordance with manufacturer’s recommendation. Add ultraviolet inhibitors to paint subject to sunlight exposure.

E. Clear Linear Polyurethane Finish: Provide pretreatment, primer, and matte or semi-gloss finish coatings in accordance with manufacturer’s recommendations. Apply 1.5 to 2.0 mils (0.0375 to 0.050 mm) dry film thickness.

2.8 GRAPHIC APPLICATION

A. Preparation: Surfaces to receive the graphic markings shall be clean, dry, and otherwise made ready for application of the materials. Accurately measure and lay out the required marking configurations as indicated on drawings.

B. Vinyl Die-cut and Pattern-cut Graphics: Use pressure sensitive, non-yellowing, non-peeling and weather resistant vinyl adhesive letters or images, custom flood coated as required, die cut from ScotchCal or ScotchLite as manufactured by 3M Company. Apply in strict accordance with manufacturer’s instructions. Make uniformly smooth and free from bubbles, wrinkles, stretching and blemishes.

C. Painted or Silk-screened Graphics: All graphics shall be applied using photo processed screens from camera ready art, arranged to furnish sharp and solid images without build-up or bleeding of the coating. Comply with coating manufacturer’s application instructions. Provide proper type of primer to suit each substrate and obtain a permanent bond. Verify compatibility of each substrate with the coatings to be used in the Work. Apply the markings with neat edges, minimum 3 mils (0.075 mm) dry film thickness and as required to obtain solid markings without voids.

D. Acid-Etched Graphics and Typography: Acid-etched typography and graphic imagery must be an average of 1/16” deep, with clean, crisp, sharp edges; ragged or soft (polished out) edges will be rejected. Acid baths used for etching shall be fresh and used in an environment and temperature that will provide the highest quality etched images. Color fill as indicated by the S/P color and finish schedule, keeping inks and fills true to the edges of letterforms / graphics.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Inspect all surfaces to receive signage and report all defects that would interfere with signage installation.

B. Starting Work implies acceptance of surfaces as satisfactory.

C. Verify all conditions and sign dimensions in field. Contractor to review and study architectural, landscape, lighting, electrical and related plans to ensure that all proposed signs can be installed and supported. Verification of conditions and sign dimensions to be completed prior to sign fabrication and reviewed with the architect.

3.2 DEMOLITION

A. Existing signage to be removed and responsibly disposed of.

B. Installation of new signage to be installed immediately after any demolition.

C. Temporary signage, if necessary, is to conform with Contact Drawings for temporary signage.

D. Unused data and/or electrical feeds to be coordinated with IHS for proper terminations.

E. Any surfaces damaged should be repaired and painted/patched to match adjacent surface.

F. Concrete and floor surfaces to be repaired in coordination with the IHS.

3.3 INSTALLATION

A. Install signage upon acceptance by IHS of material and substantial completion of job site area to receive such materials.

B. Special Precautions: Guard against damaging existing pavements and planting where signage is to be installed.

C. Footings beneath topping surface shall be installed and located prior to top surface installation.

D. Prior to installation, check all components, nuts, bolts, and other connections for proper alignment, fit and any damage. Replace damaged or defective components.

E. Prior to installation, confirm all electrical locations and requirements with IHS.

3.4 CLEAN UP

A. Keep areas of work clean, neat, and orderly at all times. Clean surfaces, inside and out. Use approved cleaners, if necessary, to remove dirt.

B. Protective coverings and strippable films shall be removed at a time that will afford the greatest protection of the furniture. Surfaces shall be cleaned to remove excess glazing and sealant compounds, dirt, and other substances.

C. Upon completion of work and before final acceptance, remove tools, surplus materials, apparatus, and debris from the site. Leave the site in a neat, clean condition, acceptable to the Engineer. Wash, clean, and leave paved areas without stains.

3.5 FINAL INSPECTION AND ACCEPTANCE

A. Upon completion of work, IHS will perform a final inspection for acceptance.

B. All unused mock-ups and unused submittals shall be removed from site prior to final acceptance.

C. Submit operation manuals, tools, and keys as specified in this Section.

END OF SECTION

SECTION 123553 - GENERAL REQUIREMENTS FOR LABORATORY CASEWORK AND FUME HOODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes laboratory casework with supplementary items necessary to complete their installation.

1. Manufacturers.
2. Seismic Performance.
3. Mock-up Requirements.
4. Tables.
5. Adjustable Shelving.
6. Electrical Service Fixtures.
7. Under-Cabinet/Shelving Task Lighting.
8. Umbilicals / Service Drops.
9. Overhead Service Carriers (The Wing).
10. Gas Cylinder Restraints.

B. Related Requirements:

1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.

1.2 REFERENCES

A. American Hardboard Association (AHA).
1. A135.4 – Basic Hardboard.

B. Americans with Disabilities Act (ADA).

C. American National Standards Institute (ANSI).

1. ANSI A117.1 – Accessible and Useable Buildings and Facilities.
2. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

D. American Society for Testing and Materials (ASTM).
1. ASTM A1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
2. ASTM B221/B221M – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

3. ASTM C1036 – Specification for Flat Glass.
4. ASTM D785 – Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.

5. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

E. Business and Institutional Furniture Manufacturers Association (BIFMA).

F. Factory Mutual (FM).

G. Forest Stewardship Council (FSC).

H. Leadership in Energy and Environmental Design (LEED).

I. National Electrical Manufacturers Association (NEMA).
1. NEMA LD3 - High-Pressure Decorative Laminates.

J. National Fire Protection Association (NFPA).
1. NFPA 30 - Flammable and Combustible Liquids Code.
2. NFPA 45 - Standards on Fire Protection for Laboratories Using Chemicals.

K. Office of Safety and Health Administration (OSHA).

L. United States Department of Commerce, National Institute of Standards and Technology
1. PS 1 – Construction and Industrial Plywood.
2. PS 51 – Hardwood and Decorative Plywood.

M. Scientific Equipment and Furniture Association (SEFA).
1. SEFA Desk Reference.

N. Underwriters Laboratories (UL).

O. Woodwork Institute (WI).

1.3 PREINSTALLATION CONFERENCE

A. Before Work begins, conduct conference at Project site to comply with requirements of applicable Division 01 Sections.
1. Required Attendees:
a. Owner.
b. Architect.
c. Contractor, including superintendent.
d. Installer, including project manager and supervisor.
e. Manufacturer/fabricator's qualified technical representative.
f. Installers of other construction interfaced with Work.
2. Minimum Agenda: Installer shall demonstrate understanding of the Work required by describing detailed procedures for preparing, installing, and cleaning the Work. Demonstration shall include, but not be limited to, following topics:
a. Tour representative areas of Work, inspect and discuss condition of substrate, and other preparatory work performed by other trades.
b. Review Work requirements (Drawings, Specifications, and other Contract Documents).
c. Review required submittals, both completed and yet to be completed.
d. Review and finalize construction schedule related to Work and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.

e. Review required inspection, testing, certifying, and material usage accounting procedures.
f. Review environmental conditions and procedures for coping with unfavorable conditions.
g. Resolve deviations or differences between Contract Documents and the manufacturer/fabricator's specifications.

3. Record discussions of conference, including decisions and agreements reached, and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.

1.4 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for lateral support of wall and tall cabinets.

1.5 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's data for each item of laboratory furnishings and equipment. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size, and service requirement for each utility connection.

B. Sustainable Design Submittals
1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include invoice that identifies vendors chain-of-custody certification number, FSC content designation, and cost on a line-item basis.
3. Chain-of-Custody Qualifications: For manufacturer and vendor.
4. Product Data: For composite wood products indicating compliance with Formaldehyde Emissions Evaluation.

C. Shop Drawings: Include the following:

1. Location of assemblies in each room to include plans, elevations, sections, and attachment details for casework, fume hoods, canopy hoods, point exhausts and ceiling service panels. Include roughing-in information for mechanical, plumbing, and electrical connections.
2. Details of construction.
3. Details of connections between units and to adjacent work.

4. Indicate details for anchoring laboratory casework and fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

D. Samples:
1. Submit Samples which conform to specified requirements, including construction and finishes. Samples will be retained for comparison with Work fabricated and will be returned upon completion of the Contract.

2. Submit the following Samples for approval:
   a. Casework: Metal finish, wood finish, service fixture finish, and work tops.

   b. One of each mechanical service fixture.

E. Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
   1. Provide delegated-design submittals for seismic restraints for laboratory casework and fume hoods, including items like point exhausts, canopy hoods and ceiling service panels which need to attach to structure.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer's Project Acceptance Document: Certification by the manufacturer that its product(s) are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required, and that a warranty will be issued.

B. Qualification Data: For manufacturer/fabricator, installer and professional engineer.
   1. For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
   2. Architect may waive submittal of qualification data for available manufacturers listed in this Section.

C. Test Reports: Submit test reports verifying conformance to specified performance tests.

D. Field Quality Control Reports: Written report of testing and inspection required by "Field Quality Control".

1.7 CLOSEOUT SUBMITTALS

A. Furnish maintenance instructions and complete touchup kit for each type and color of laboratory paint finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged casework and fume hood finishes.

B. Operation & Maintenance Manuals: Provide complete written instruction manuals outlining safe operating procedures, safety guidelines, and proper maintenance procedures for equipment and fume hoods.

C. Warranty: Provide manufacturer's written warranty covering materials and installation (labor) stating obligations, remedies, limitations and exclusions.

D. Receipts: Furnish receipts for keys and other loose items.

1.8 QUALITY ASSURANCE

A. Single Source Responsibility: Provide casework, work surfaces, laboratory furnishings, and accessories, all furnished by a single laboratory furniture company.

B. Manufacturer/Fabricator Qualifications: Manufacturer/fabricator with not less than 10 years experience with successful production of products and systems similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.

C. Installer Qualifications:
   1. Experience: Installer with not less than 10 years experience in performing specified Work similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.
   2. Supervision: Installer shall maintain a competent supervisor who is at Project during times specified Work is in progress, and, who is experienced in installing systems similar to type and scope required for Project.
   3. Manufacturer/Fabricator Acceptance: Installer shall be certified, approved, licensed, or acceptable to manufacturer/fabricator to install products.

D. Manufacturer's Technical Representative Qualifications: Direct employee of technical services department of manufacturer with minimum of 10 years experience in providing recommendations, observations, evaluations, and problem diagnostics. Sales representatives are not acceptable.

E. Mockups: Prior to fabrication and installation, provide a laboratory mockup where indicated on drawings. Location may be changed to meet construction phasing with approval of Architect. Components utilized meet the requirements of the Drawings and Specifications. The purpose of the mockup is to verify designs and confirm or modify the sequence of installation between the various trades. Approved mockup serves as the standard of quality against which the remaining laboratory work is measured. Build mockup to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockup in the location and of the size indicated or, if not indicated, as directed by Architect. Contractor shall provide structural support framework.
      a. Provide laboratory casework and furnishings. Furnishings, such as the fume hood, must be installed, complete with fixtures and accessories, but does not need to be operational.
      b. Provide plumbing pipe, valves, fittings, and accessories required to make connections to complete the laboratory mockup. Fixtures and furnishings are not required to be operational, but must be installed to review and ensure proper coordination.
      c. Provide electrical systems in conjunction with the laboratory mockup. Power receptacles, raceway, data back boxes and conduit must be installed, but do not need to be operational. Lighting to be fully operational.
   2. Clean exposed faces of mockup.
   3. Notify Architect fourteen days in advance of the dates and times when mockup will be installed and ready for review.

4. Make such changes and alterations to mockup as may be discussed, agreed upon, and documented in writing resulting from the review. Modifications to the mockup that are agreed upon in writing will be incorporated into the overall design of the project without change in contract sum. Obtain Architect's acceptance of mockup before starting fabrication.
5. Maintain mockup during construction in an undisturbed condition as a standard for review of the completed Work.
6. Acceptance of mockup does not constitute acceptance of deviations from the Contract Documents contained in mockup unless such deviations are specifically noted by Contractor, submitted to Architect in writing, and accepted by Architect in writing.

7. Once installed and approved the mockup becomes part of the completed Work

1.9 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of casework and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.

B. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating. Protect all work surfaces from damage throughout construction period. Do not allow standing on work surfaces during the construction period. Provide signage marked in large lettering that reads: "NO STANDING".

1.10 FIELD CONDITIONS

A. Do not deliver or install equipment until the following conditions have been met:
1. Building areas requiring the installation of laboratory casework: Dry and unexposed to adverse weather conditions which may damage finished materials.
2. The air conditioning or heating system: On and functioning in areas of casework installation to maintain the temperature between 60 and 85 degrees Fahrenheit with the relative humidity between 45 percent and 65 percent.

B. Field Measurements: Where products and systems are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.11 SEQUENCING AND SCHEDULEING

A. All overhead mechanical, electrical and plumbing rough-in work: Complete prior to laboratory casework deliveries.

B. All mechanical, electrical and plumbing rough-in work required along walls and service islands, where lab furnishings are to be installed: Complete prior to delivery of materials.

C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after lab casework and furnishings installation, protect the casework and furnishings by covering and masking prior to commencement.

D. All necessary wood or metal blocking must be installed within partitions prior to delivery of casework and furnishings.

E. Overhead soffits and ceiling grid must be in place prior to casework installation.

F. Overhead lighting must be installed and connected prior to casework installation.

G. All flooring required to be placed under lab casework systems must be installed prior to lab casework material delivery.

H. Concrete floors must be level within 1/8 inch of level per 10 foot run, nonaccumulative, when tested with a straight edge in any one direction.

I. Wet operations to be performed must be complete prior to material deliveries.

1.12 WARRANTY

A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required.

1. Warranty Period: Manufacturer shall warrant the products to be free from material and labor defects for a period of 1 year from date of operational acceptance by the Using Agency.
2. Date of operational acceptance shall be after factory check, test and start-up services is complete, the unit is operating in a satisfactory manner, and the equipment has been satisfactorily commissioned by the Using Agency.

B. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

A. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".

1. ICI Scientific.
2. Mott Manufacturing Limited.

B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

1. Basis of Design: Mott Manufacturing, Inc.

C. Furnish and install casework, fume hoods, furnishings and equipment specified in the following sections by the same supplier.

1. Section 123553.03 - Adaptable Laboratory Casework Systems.
2. Section 123553.19 - Wood Laboratory Casework.

2.2 PERFORMANCE REQUIREMENTS

A. Contract Documents Design Intent: Drawings and Specifications indicate design intent for products and systems and do not necessarily indicate or specify total Work required and shall not be construed as an engineered design. Furnish and install all Work required for a complete installation.

B. Coordination of Contract Documents and Work:
1. Product Variations: In the event of minor differences between products and systems of acceptable or available manufacturer/fabricators, Contractor shall notify Architect of such differences and resolve conflicts in a timely manner. Failure of Contractor to provide notification shall be construed as acceptance of conditions indicated, and changes caused by minor differences between products and Contract Documents shall be included in the Work at no additional cost to Owner.
2. Allowable Adjustments: Minor dimension and profile adjustments may be made in interest of fabrication or erection methods or techniques or ability to satisfy design intent, provided design intent is maintained as determined by Architect. Proposed deviations shall include a detailed analysis of impact to adjacent substrates or other building systems, including related design or construction cost impacts. If accepted by Architect, deviations causing changes in materials, constructability, substrates, or conditions shall be included in the Work at no additional cost to Owner.

C. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design laboratory casework and fume hoods for seismic performance.

D. Seismic Performance: Laboratory casework, fume hoods, and support framing system, including attachments to other work, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Design earthquake spectral response acceleration, short period (Sds) for Project is .213g.
2. Component Importance Factor: 1.0.
3. Base Cabinet Load (Including Countertop and Load on Countertop): 320 lb/ft.
4. Wall Cabinet (Upper Cabinet) Load: 160 lb/ft.

2.3 CASEWORK, GENERAL

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. Certified Wood: Wood cabinets shall comply with requirements of ASTM D7612-10 (FSC, SFI, ATSM, CSA or PEFC certifications are acceptable).

C. Steel systems: Recycled Content: Post-consumer recycled content plus one-half pre-consumer recycled content shall not be less than 80 percent.

2.4 MATERIALS

A. Wood:
1. Composite Wood Products:

a. Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

2. Definition of cabinet components by surface visibility.
a. Exposed Exterior Surfaces: Defined as all exterior surfaces exposed to view:
1) All surfaces visible when doors and drawers are closed, including knee spaces.
2) All sides of cabinets that abut other casework but will become visible when the casework is reconfigured.
3) All exterior surfaces of suspended casework.
4) All exterior surfaces of mobile casework.
5) Underside of cabinet bottoms 42 inches or more above finished floor, including cabinet bottoms behind light valances and the bottom edge of light valances.
6) Cabinet tops under 80 inches above finished floor, or if 80 inches and over and visible from an upper floor or building level after installation.
7) Visible front edges of stretchers, ends, dividers, tops, bottoms, shelves, and hanging stile.
8) Visible portions of bottoms, tops, and ends in front of sliding doors.
9) Sloping tops of cabinets.
10) Visible portions of cabinets after fixed appliances are installed.
b. Exposed Interior Surfaces: Defined as all interior surfaces exposed to view in open casework or behind transparent doors:
1) Fixed, adjustable and pull-out shelves, including edgebanding of all sides.
2) Dividers and partitions.
3) Interior face of ends (sides), backs, and bottoms, including Interior surfaces of cabinet top members 36 inches or more above the finished floor.
4) Interior face of door and applied drawer fronts.
c. Semi-exposed Surfaces: Defined as those interior surfaces exposed to view when doors or drawers are opened:
1) Fixed, adjustable and pull-out shelves, including edgebanding of all sides.
2) Dividers and partitions.
3) Interior face of ends (sides), backs, and bottoms on cupboard and drawer units, including the interior surfaces of cabinet top members 36 inches or more above finished floor.

4) Drawer sides, sub-fronts, backs, and bottoms.
5) The underside of cabinet bottoms between 24 inches and 42 inches above finished floor.
6) Security and dust panels or drawer stretchers.

d. Concealed Surfaces: Defined as those exterior and interior surfaces that are covered or not normally exposed to view:
1) Toe space unless otherwise specified.
2) Sleepers, stretchers, security panels, and solid sub-tops.
3) Underside of bottoms of cabinets less than 24 inches above finished floor.
4) Flat tops of cabinets over 80 inches above finished floor and not visible from an upper level.
5) The three non-visible edges of adjustable shelves.

3. Hardwood Lumber:
a. Type 1 Hardwood: Plain sawn white Maple Grade FAS, first and seconds or better, well matched for color and grain.
b. Type 2 Hardwood: Select grade hardwood of a species suitable for the specified purpose.
c. Provide all lumber clean and free of defects; kiln and air dried to a uniform minimum moisture content of 6 percent.

4. Hardwood Plywood:
a. In accordance with ANSI/HPVA HP-1 latest edition unless otherwise specified herein.
b. Face Veneer:

1) Grade:
a) Middle or higher of A-1.

2) Species:
a) Exposed and Semi-Exposed Surfaces: Select White Maple.
b) Concealed Surfaces: Plain sliced hardwood veneer, suitable for unexposed surfaces.

3) Cut:
a) Plain Sliced, 1/50 inch thick minimum.

4) Matching Type:
a) Book.

5) Grain Direction:
a) Vertical matched grain direction on cabinet drawer heads, doors, end panels, KO panels, KO aprons, table aprons, and filler panels.

6) Color and Matching Selection:
a) Compatible in color with solid stock and well matched in color and grain with adjacent plywood panels.

b) Hand select plywood prior to fabrication of cabinet faces for uniformity of color and grain on each run of bench. Darker and lighter panels are not acceptable in the same run of bench or same room after installation of casework.

c. Cores:
1) Veneer: One piece hardwood solid core with crossbanding and hardwood face veneers. Minimum 9 ply for 1 inch, 7 ply for 3/4 inch, 5 ply for 1/2 inch, and 3 ply for 1/4 inch.
2) Combination with composite crossbands: Minimum 7 ply for 3/4 inch. One piece hardwood solid core with two hardwood solid and two MDF crossbands and hardwood face veneers. MDF crossbands under face veneers.
3) MDF: Medium density fiberboard, Grade 130-MR50 with hardwood face veneers.
4) Particleboard: Medium density, Grade M-3 particleboard with hardwood face veneers.

d. Bond Type: Type II.

5. Hardboard:
a. Tempered hardboard designed for strength and moisture resistance; consisting of wood fibers, highly compressed into a hard, dense, 1/4 inch thick, homogeneous sheet using natural resins and other added binders.
b. Physical Properties:
1) Average modulus of rupture: 5300 psi.
2) Density: 50 to 60 pounds per cubic foot.
3) Tensile strength: 3,500 psi.

B. Sheet Steel: ASTM A1008 /1008M mild steel, cold-rolled, pickled, double annealed, and free from rust, scales, deep scratches, buckles, ragged edges, and other defects. Provide metallic furniture stock sheets.

C. Metal Gages for Sheet Steel:
1. Construct metal cabinets of sheet steel with minimum thickness in U.S. standard gage as follows:

Corner gussets for leveling bolts	11 gage (3.2 mm)
Apron corner braces, wall rail systems	12 gage (2.7mm)
Drawer support, hinge reinforcement, reinforcing gussets	14 gage (1.9 mm)
Horizontal rails and top rails, aprons, support struts, adjustable wall and island shelving, shelving hat channels	16 gage (1.5 mm)
Cabinet tops, end panels, bottoms, backs, toespace rails, security panels, vertical posts, vertical dividers, glazed doors, scribe strips, filler panels	18 gage (1.2 mm)
Door panels	18 gage (1.2 mm)

	exterior 20 gage (0.9 mm) interior
Enclosures, drawer fronts and bodies, pull-out tablet fronts and bodies, cabinet shelving, closure panels, overhead service carriers	20 gage (0.9 mm)

D. Aluminum Type: Unless otherwise noted on Drawings or elsewhere in this Section, provide extruded aluminum per ASTM B 221 in either alloy 6063-T42 or 6063-T5.

E. Epoxy Resin Sheets:
1. Molded from modified epoxy resin that has been compounded and cured to provide optimum physical and chemical resistance required of a heavy duty laboratory working surface. Uniform mixture throughout, not dependent on a surface coating.
2. Physical Properties:
   a. Compressive Strength (ASTM D695): 30,600 psi.
   b. Flexural Strength (ASTM D790): 12,800 psi.
   c. Tensile Strength (ASTM D638): 10,100 psi.
   d. Heat Distortion (ASTM D648): 330 degrees F.
   e. Water Absorption (ASTM D570): 0.018 percent.
   f. Hardness, Rockwell M (ASTM D785): 108.
   g. Fire Resistance (ASTM D635): Self Extinguishing.

F. Glass:
1. Laminated safety glass: Two outer plies of glass with a vinyl interlayer, nominal 1/4 inch thick.
2. Tempered safety glass: Heat treated glass, nominal 1/8 inch thick with a minimum of 88 percent clarity.

2.5 HARDWARE

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Drawer and Hinged Door Pulls: 3/8 inch diameter stainless steel wire pull, 4-3/4 to 5-1/16 inches center to center with radiused corners and a projection of 1 inch to 1-1/2 inches. Model DP57C as manufactured by Mockett, Model 115.61.602 as manufactured by Hafele America Co., or Model CC01-MC402-5-SS by Hardware Décor.
1. Mount door pulls vertically and drawer pulls horizontally.
2. Provide drawers 28 inches wide and smaller with one pull per drawer at centerline of cabinet.

C. Retracting Grab Bar Handless for Mobile Cabinets: Provide stainless steel folding handle in recessed tray, handle nominal 3 inches by 2 inches recessed 1/2 inchinto cabinet end panels. Model RHEE-07.39 as manufactured by Elesa USA Corporation, Model 06961-01 as manufactured by Norelem, or Model EE-03 as manufactured by Rohde.
   1. Provide two handles per mobile cabinet, mounted to each side, within 8 inches of cabinet front and 8 inches f cabinet top.
   2. Mobile cabinets with the add-a-drawer option: Mount grab bar handles in lower portion.

D. Rear Bumpers for Mobile Cabinets: Provide round, clear, screw-on bumpers with integrated screw hole, 7/8 inch by 3/8 inch into back of cabinet. Model 9072 as manufactured by Shepherd Hardware Products.
   1. Provide two bumpers per mobile cabinet, mounted to back, within 1 inch of cabinet top.

E. Drawer and Pullout Shelving Slides:
   1. Description: Full extension with soft closing action, ball bearing, rail mounted, multimembered slides fabricated of minimum 16 gage steel with an electro-zinc finish.
   2. Acceptable Manufacturers:
      a. Accuride International Incorporated, Santa Fe Springs, California
      b. CompX Precision Slides, Waterloo, Ontario Canada
      c. Knape and Vogt, Grand Rapids, Michigan
   3. Drawer and Pullout Shelving Slide Ratings:
      a. Drawer Width: 0 - 24 inches Maximum dynamic load rating 100 pounds
      b. Drawer Width: Over 24 inches Maximum dynamic load rating 200 pounds
   4. File Cabinet Drawer Slide Ratings:
      a. Drawer Width: All sizes Maximum dynamic load rating 150 pounds
   5. Slides shall have progressive movement with a positive stop at full extension or at a minimum 1 inch over travel and permit removal of drawer without use of tools. Drawers shall not lift out or otherwise be removable without the release of a locking device on each slide.
   6. Dynamic Load Rating: Slides meet BIFMA "Business Institutional Furniture Manufacturers Association" Standards. 0.017 pounds per cubic inch at full travel plus or minus 1/4 inch for 50,000 cycles.

F. Pull-out Shelf Bumper: Provide on hinged side of pull-out shelf.
   1. Basis of Design: Bainbridge Manufacturing, Inc., Part Number 1934.

G. Hinges:
   1. Description: Institutional type, 5-knuckle, projecting barrel, minimum 2-1/2 inches long. Hinges for full overlay cabinets to have a wraparound design and slotted screw holes for adjustability.
   2. Material: Type 304 stainless steel, minimum 0.095 inches thick.
   3. Provide minimum of 2 hinges for doors under 48 inches high; minimum of 3 hinges for doors 48 inches to 84 inches high; and minimum of 4 hinges for doors over 84 inches in height.
   4. Mounting: Drill each leaf for screw attachment to door and frame. Use stainless steel flathead screws.

H. Door Catches: Roller or magnetic type, adjustable, roller type operating with a built-in tension spring. Provide all parts of cadmium plated steel except roller. Attach to top of base cabinet doors, the bottom of wall cabinet doors, and at the top and bottom of tall cabinet right-hand doors. Provide a vertical sliding bolt assembly, astragal strip and dummy pull for the left-hand door of tall cabinets. Vertical sliding bolts; concealed in the stiles of glazed doors and between pans of solid doors to engage stainless steel keepers.

I. Doorstop:
1. Provide at all tall cabinets with glass doors located adjacent to a benchtop or perpendicular surface, such as a wall.
2. Provide with base and wall cabinets located adjacent to a perpendicular surface, such as a wall.
3. Chain or cable, secured to the top of the door and cabinet frame. Provide in lengths required to stop the door from opening more than 90 degrees.

J. Shelf clips: Die formed steel, zinc plated or polycarbonate clip with grooved plug and spring clip. Provide shelf clips adjustable on 1-1/4 inch centers and meet seismic requirements. For metal cabinets shelf adjustment holes are on nominal 1/2 inch centers.

K. Label Holders:
1. Description: Formed steel with satin chrome finish, 3-1/2 inch wide by 1-1/2 inch high, to accept card size of 2-3/4 inch wide by 1-1/4 inch high, screw installed.
2. Provide one label holder for every drawer and door. When cabinets have multiple drawers, doors, or a combination of both, provide a label holder for every drawer and door on each cabinet.
3. Label holders are not required for cabinets with glass fronts or chemical storage (i.e., flammables, corrosives, bases, etc.).
4. Coordinate location of label holder during shop drawing review.

L. File Suspension Rails: Provide each file drawer with a pair of 14 gage steel, file suspension rails.

M. Leveling Glides: 2 inch diameter, two-piece pivot construction, steel housing, non-marring, phenolic or translucent plastic insert, 1/2 inch diameter, minimum 1-1/2 inch long zinc plated stems.

N. Mobile Cabinet Casters - Swivel Type: 3 inch overall height, with toe brake. Provide minimum load rating of 165 pounds per caster.
1. Basis of Design: Shepherd Softech PSF75101BK-B.

O. Retractable Table Casters - Swivel Type with Retractable Leveling Glide: 4 inch overall height, with leveling glide that can be raised or lowered to handle the table load and prevent movement. Provide minimum load rating of 660 pounds per caster.

1. Basis of Design: Zambus CarryMaster; Model AC-600S.

P. Anti-Tip Interlock: Provide in all mobile cabinets with drawers and adjustable pullout shelves. Provide with snapper actuator, lockbar, adjustable locking pins, drawer wedges, lockbar retainers, and wedge lock.

1. Basis of Design: Compx Timberline, System 350.

Q. Drawer Protection and Identification Plate: Plate, Type 304 stainless steel, 16 gage with a number 4 finish. Attach plate to drawer with flathead stainless steel screws countersunk at each corner. Engrave each plate with 1/2 inch high numbering. Numbering selected by the Owner's Representative. Padlock eyes, Type 304 stainless steel, 12 gage with a number 4 finish. Padlock provided by Owner.

R. Grommets in Countertops: Manufacturer: Outwater Plastic Industries, Wood Ridge, New Jersey, (800) 631-8375, Model Number 35 DG, Dove Gray, or equal (no known equal). Seal Grommets to bench with silicone sealer.

S. Seismic Clips: Anchor rear support structures and legs of adaptable laboratory casework system assemblies to prevent overturning and movement during a seismic event.

2.6 TABLE - METAL LEG FRAME, ADJUSTABLE HEIGHT

A. Perimeter rails: 2 inches by 2 inches by 12 gage steel channel with a continuous inner reinforcement U-channel. Spot weld inner reinforcement channel approximately 12 inches on center, staggering weld on each side.

B. Legs: 1-1/2 inch by 1-1/2 inch by 12 gage steel tubing. Height adjustment to be accomplished through inner telescoping leg and spring bolts.

C. Provide each leg with leveling glides and/or casters as scheduled on the drawings

D. Inner leg: 27-1/4 inches long inner telescoping leg extension. Provide with six 9/16 inch round holes on inside of table for spring bolts. Provide each leg with a leveling glide unless otherwise noted.

E. Quick Release Pins: Provide each leg with two 1/2 inch diameter by 2-1/2 inch usable leg stainless steel push-button, quick-release pins, McMaster-Carr model 92384A096, or equal.

F. Stretcher rails: 2 inches by 1-1/4 inch by 16 gage steel tube. Connect by welding between two end legs and between two back legs.

G. Finish: Finish as specified for Metal Finishes under this section.

H. Tops: As specified for Work Surfaces under this section. Refer to Table Schedule for type.

2.7 SHELF FRAME ASSEMBLIES

A. Nominal Shelf Dimensions:
1. Width: 24 inches, 30 inches, 36 inches 914 mm), 42 inches or 48 inches
2. Depth and weight capacity: 6 inches, 8 inches, 12 inches, or18 inches; 130 pounds. 24 inches; 100 pounds
3. Thickness: 1 inchGeneral Requirements:
1. Shelves shall have a 1 inch overhang behind the face of the rear tubular posts.

2. Shelf Brackets: 11 gage metal with 3 blade hooks and rise above the shelf surface 6-inches to provide sides. Depth to match shelf depth. Provide one pair for each shelf. Screw shelves to each bracket. Top shelf assemblies shall have inverted shelf brackets.

3. Front Retainer Rod: Type 304 stainless steel 1/4 inch diameter rod with a number 4 polished finish. Bend 90 degrees at 1-1/2 inches from each end. Insert bent ends into shelf to a depth of 1/2 inch with horizontal portion of rod at 1 inch above shelf.
4. Front Retainer 'P' Clip: Type 304 stainless steel 1/4 inch diameter rod with a number 4 polished finish. Stop rod at 1-1/2 inches from each end of shelf. Insert rod into 'P' clip, maximum spacing of 'P' Clip is 24 inches on center. Maximum spacing of 'P' clip to end of rod is 2 inches. Construct the 'P' clip from 11 gage by 1/2 inch wide Type 304 stainless steel with a number 4 polished finish. Attach 'P' clips to front of shelf edge using stainless steel screws.
5. Front Clear Retainer Strip: 1/4 inchthick by 2 inches high, clear polycarbonate resin. Attach to front of shelf with stainless steel round head screw and washer at 12 inchon center.

C. Wall Frame Assemblies:
1. Standards: 16 gauge metal, single-slotted or double-slotted type on 1 inch centers, 30 inches long and 1 inch depth.
2. Cross Rails and Cross Rail Brackets: 16 gage metal.
3. Brackets: 11 gage metal with 3 blade hooks and rise above the shelf surface to provide sides. Screw shelves to each bracket.

D. Adaptable Frame Assemblies: Refer to Section 123553.03 Adaptable Laboratory Casework Systems.

E. Shelf Materials:

1. Refer to Section 123553.19 for Wood.

F. Finish as specified for metal finish in this section.
1. FINISHES

G. Metal Finishes:
1. Finish casework, casework support structure, fume hood super-structure and other laboratory furnishings.
2. Preparation: Spray clean metal with a heated cleaner / phosphate solution, pretreat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled, prior to application of finish.
3. Application: Electrostatically applied epoxy or urethane powder coat painting process that coats all hidden and exposed surfaces with an acid and abrasion resistant coating. Bake in a controlled high temperature oven to ensure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
    a. Exterior and interior surfaces exposed to view: 1.5 mil average and 1.2 mil minimum.
    b. Backs of cabinets and other surfaces not exposed to view: 1.0 mil average.

c. Finish drawer bodies in matching or harmonizing color and apply corrosion resistant treatment to selected, concealed interior parts.

4. Color: Select from standard colors.
5. Metal Finish Performance Requirements:
   a. Abrasion Resistance: Maximum weight loss of 5.5 mg per 100 cycle when tested on a Taber Abrasion Tester Number E40101 with 1000 gm wheel pressure and Calibrase Number CS10 wheel.
   b. Hardness: Surface hardness equivalent to 4H or 5H pencil.
   c. Humidity Resistance: Withstand 1,000 hour exposure in saturated humidity at 100 degrees F.
   d. Moisture Resistance: No visible effect to surface finish after boiling water trickled over test panel inclined at 45 degrees Fahrenheit for 5 minutes. No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.
   e. Adhesion: Score finish surface of test panel with razor blade into 100 squares, 1/16 inch by 1/16 inch, cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.
   f. Salt Spray: Withstand minimum 200 hour salt spray test, conforming to ASTM B117-59 procedure.

2.8 COAT RACK, LAB (MQ-100)

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. ~~Available~~ **Basis of Design** Manufacturer~~s~~ Coat Rack:
   ~~1. Global Industrial, Model T9F695715.~~
   2. ~~Bradley, Model 9944-000000.~~ (Add. A)
   3. Safco, Model 4162.

C. Size: **36** ~~26~~ inches wide by 2-5/8 inches deep by 7-1/4 inches high nominal dimensions. **(Add. A)**

D. Type: Multiple hat and coat hooks, wall mounted on mounting backplates.

E. Construction: 22 gauge stainless steel back plate with14 gauge stainless steel double hooks.

F. Name Plate: Provide 1” high by 4” wide metal name plate for each coat hook.
   1. Basis of Design Manufacturer: Lone Star Badge & Sign
   2. Mechanically fasten with 2 screw holes.
   3. Color: Silver
   4. Slide-in holder for inserts up to 1/16” thick (Add. A)

2.9 WORK SURFACES

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Epoxy Resin:
   1. Available Manufacturers:
      a. American Epoxy Scientific, LLC.
      b. Durcon, a Wilsonart Company
      c. Kewaunee Scientific Corporation
   2. Thickness: 1 inch thick unless otherwise noted on Drawings. Check thickness before fabrication. Each corner of top shall not deviate more than plus or minus 1/32 inch from nominal.
   3. Warpage: Check top for warpage before fabrication. Place slab on a true plane formed by a surface plate of Tool Room Grade B or better. Measure in unrestrained condition. Top will be accepted for use if there is no gap exceeding 1/16 inch in a 36 inch span or 3/32 inch in a 96 inch span.
   4. Fabrication:
      a. Provide in longest practical lengths. Bond all joints with a highly chemical and corrosion resistant cement having similar properties as the base material. Provide a 1/8 inch wide drip groove on underside of all exposed edges set back 1/2 inch from edge of top. Finish exposed edges.
      b. Size Tolerances: Length, plus or minus 1/8 inch. Width, plus or minus 1/16 inch.
      c. Size Tolerances: Length, plus or minus 1/8 inch. Width, plus or minus 1/16 inch.
      d. Squareness: Plus or minus 1/64 inch for each 12 inches. A top spanning 48 inches; held to plus or minus 1/16 inch.
      e. Location Of Cutouts And Drillings: Plus or minus 1/8 inch.
      f. Sizes Of Cutouts And Drillings: Plus 1/8 inch, minus 0.
   5. Curbs: Supply loose for field application. Provide curbs 4 inches high by 3/4 inches thick unless otherwise indicated on Drawings. Where tops abut wall, casework, or fume hood, supply an end curb. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.
   6. Color: To be selected by the Owner's Representative from the Manufacturer's standard colors.

2.10 SINKS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Epoxy Resin Sink:

1. Available Manufacturers:
   a. American Epoxy Scientific, LLC.
   b. Durcon, a Wilsonart Company.
   c. Or equal, (no known equal).
2. Description: Integrally molded from modified thermosetting black epoxy resin, and oven cured. Minimum wall thickness of 1/2 inch with all interior corners coved to 1-1/2 inch radius and bottoms pitched to end outlet opening.
3. Sink mounting methods:
   a. Drop-in: Supported by an upper flange from the work surface. Top edge of sink positioned 1/8 inch below the work surface with a 30 degree bevel from the top of the work surface to the top of the sink lip. Joint between sink and work surface shall not exceed 1/8 inchplus or minus 1/16 inch. Seal joint between sink and top with epoxy sealant.
   b. Under Mount: Support sink at bottom using an upper direction compression support system. Seal joint between top and sink with silicone sealant.
4. Provide sink with the following accessories:
   a. Outlet: 1-1/2 inch NPS.
   b. Overflow: Open end overflow standpipe. Overflow to be 2 inches shorter than depth of sink.
   c. Strainer: Removable disc strainer.
   d. Tailpiece: Town & Country Plastics Model PP-18, R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number W81595-158.

C. Epoxy Resin Oval Cupsink:
1. Available Manufacturers:
   a. American Epoxy Scientific, LLC.
   b. Durcon, a Wilsonart Company.
   c. Or equal, (no known equal).
2. Description: 3 inches by 6 inches ID with a minimum wall thickness of 3/8 inch. Integrally molded from modified thermosetting black epoxy resin, oven cured. Cove corners and pitch bottom to outlet opening.
3. Provide sink with the following accessories:
   a. Strainer: Removable disc strainer.
   b. Tailpiece: Town & Country Plastics Model PP-18; R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number W81595-158.

D. Cupsink Mounting Bracket:
1. Fabricate from 16 gage sheet metal. Construct as detailed on the Drawings. Secure bracket to mounting surface using stainless steel fasteners. Caulk cupsink to bracket and joint between bracket and mounting surface with an acid-resistant silicone caulk.
2. Finish: Finish as specified for metal finish in this section, with color selected by Owner's Representative.

2.11 LABORATORY SERVICE FIXTURES

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. General:
   1. Installation: Provide and install at point of use all service fixtures. Connect to the service piping systems specified in Division 22. Provide the product of one manufacturer for all laboratory service fixtures, including fixtures supplied with fume hoods and emergency shower and eye wash units. Provide all fixtures designed for laboratory use and comply with SEFA 7.
   2. Refer to Laboratory Service Fixture Schedule for fixture types and descriptions.
   3. Acceptable Manufacturers:
      a. WaterSaver Faucet Company. WaterSaver fixture numbers are referenced herein.
      b. Broen-LAB A/S
      c. Chicago Faucet Company.
   4. Materials: Provide the bodies of service valves, fixtures and accessories of cast or forged brass with a minimum copper content of 85 percent. Fabricate assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles, and straight serrated hose ends from solid brass bar stock. Fabricate replaceable seats, needle cones, valve disc screws, and other accessories from monel metal or stainless steel alloys especially selected for use intended.
   5. Provide water faucets that meet the requirements of the United States Safe Drinking Water Act as lead-free
   6. Assembled at the factory: Service fixtures, including the mounting of valves and shanks to turrets, flanges, and other mounting accessories.
   7. Furnish and install nipples, locknuts, washers, shanks and other accessories required to properly mount and connect the fixtures.
   8. Testing: Individually factory test fixtures. Valves and fixtures, except water fixtures, shall withstand a test pressure of 100 pounds per square inch. Test water fixtures at 80 pounds per square inch.
   9. Fixtures located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform, related appearance, regardless of valve type.
   10. Identify mechanical services with full view colored index buttons in accordance with SEFA 7 Color Code.

C. Water Valves:
   1. Renewable unit containing all working parts which are subject to wear, including stainless steel or monel metal seat, monel metal screw, heavy duty seat disk, Teflon packing, and an integral or external adjustable volume control.

2. Provide unit capable of being readily converted from compression to self closing, and vice versa, without disturbing faucet body proper and shall also be capable of being readily converted from water construction to needle valve or steam valve construction without disturbing faucet body.
3. Provide unit sealed in valve body with special composition gasket. Metal-to-metal or ground-joint type of sealing not acceptable.

D. Needle Valves:
1. Vacuum, gas, and air needle valves shall have a stainless steel replaceable floating cone that is precision ground and self-centering.
2. Action of valve: Slow compression for fine control under pressure up to 150 psi and shall have parts subject to wear, easily replaceable.

E. Fine Control Valves:
1. Fine Control valves for special gas service: As described for needle valves with the following additions.
   a. Fine stem threads with approximately 30 threads per inch.
   b. Renewable stainless steel needle and seat with 1/8 inch orifice.
   c. Constructed to maintain a constant flow rate of 4 bubbles per 15 seconds as valve is tested out under 50 pounds, 100 pounds, 150 pounds, 200 pounds, and 250 pounds of nitrogen pressure.

F. High Purity Water Valves:
1. Forged brass body with all interior components coming in contact with water constructed of polypropylene.
2. Maximum working pressure of 50 psig.
3. Provide with 3/8 inch brass riser and gooseneck with polypropylene lining.
4. Provide with polypropylene serrated tip at the outlet.

G. Laboratory Ball Valves: Straight pattern body, valve stem with integral chrome plated ball and TFE-coated O-rings stem seals in valve body, molded TFE valve seals, and tested at 125 psi nitrogen under water. Valves shall have chrome plated forged brass lever-type handle with screw-on type index requiring less than 5 pounds pressure to actuate. Provide with removable 10 serrated hose end.

H. Foot-Operated Water Valves:
1. Forged brass body and pedals mounted on hinged bracket.
2. Self-closing renewable unit containing all working parts which are subject to wear, including stainless steel or monel metal seat, monel metal screw, heavy duty seat disk, Teflon packing, and an integral or external adjustable volume control.

I. Goosenecks: Hot water/cold water gooseneck mixers shall swivel. Provide swivel point at turret or at valve level if wall or panel mounted. Provide swing joints with heavy Teflon packings. All goosenecks shall provide full thread for attachment of antisplash outlet fixtures, serrated tips or filter pumps.

J. Vacuum Breakers: Provide vacuum breakers, integral with the gooseneck where required. Vacuum breakers shall have a forged brass body, renewable seat and a special design valve member for fine flow control. Vacuum breakers shall not spill over at low water volume. At fume hoods provide vacuum breakers externally mounted on face of fume hood superstructure where required as part of the factory pre-piping.

K. In-line Backflow Preventer: Provide in-line dual check backflow preventer, integral with water service fixtures to maintain continuous pressure. ASSE certified under Standard 1024.

L. Aerators: Aerators shall have 3/8 inch NPS male inlet. Provide with integral flow control that adjusts between 0.5 GPM and 3.0GPM. Flow control to be set as indicated on Drawings.

M. Serrated Tips: Serrated tip fixtures shall have 3/8 inch IPS thread with hose end being tapered and shall not have less than 10 serrations. Provide 1/8 inch diameter of orifice in serrated tip, except where otherwise specified. For water units provide with integral flow control that adjusts between 0.5 GPM and 3.0 GPM. Flow control to be set as indicated on Drawings.

N. Quick Disconnect Fitting with 1/4 Inch Male NPT: For service tube ends. Each keyed disconnect shall include nipple and coupler with color-keyed band marking media.

O. Quick Connect Bodies: For service connections to flexible casework systems. Each keyed disconnect shall include nipple and coupler with color-keyed band marking media and hose between service panel and flexible casework system.

1. Finish: Chrome plated brass.

2. Provide with stainless steel braided hose with Teflon lining with a maximum working pressure of 1000 psig.

P. Fixture Finish: Fixtures shall be coated with an electrostatically applied epoxy powder coating in the color of white.

Q. Faucet and Valve Handles: Molded plastic or wrist blade type with a screw-on type index disc. Provide color coded handle to match the fixture's service. Provide color code requirements for service fixtures as follows:

Service	Index Color	Symbol	Handle Color
Air	Grey	AIR	Orange
Argon	Grey	AR	Violet
Carbon Dioxide	Grey	CO2	Pink
Chilled Water Return	Grey	CHWR	Green
Chilled Water Supply	Grey	CHWS	Green

Compressed Air	Grey	CA	Orange
Potable Cold Water	Grey	CW	Green
Potable Hot Water	Grey	HW	Red
Gas	Grey	GAS	Blue
Industrial Cold Water	Grey	ICW	Green
Industrial Hot Water	Grey	IHW	Red
Lab Air	Grey	LA	Orange
Distilled Water	Grey	DW	White
Deionized Water	Grey	DI	White
Reverse Osmosis Water	Grey	RO	White
Nitrogen	Grey	NIT	Brown
Special Gas	Grey	Varies by gas	Light Blue
Steam	Grey	STM	Black
Vacuum	Grey	VAC	Yellow

R. Wrist blade Handles: Install handles so blades are perpendicular to the benchtop in the off position and horizontal to the benchtop in the open position.

2.12 EMERGENCY SHOWER AND EYE WASH UNITS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. General: Provide and install at point of use all emergency shower and eyewash units. Connection to the service piping systems specified in Division 22. Provide units that meet the requirements of ANSI Standard Z358.1.

C. Acceptable Manufacturers:
1. Water Saver Faucet Company. WaterSaver fixtures are referenced herein.
2. Broen-LAB A/S.
3. Guardian Equipment.

D. Emergency Showers:

1. Deluge type with a concealed stay-open ball valve. Provide with "Panic Bar" activation as detailed on the Drawings.

2. Shower head and flush ceiling collar: stainless steel. Maximum mounting height of shower head 96 inches.
3. Design valve so that water flow remains on without requiring use of the operator's hands.
4. All exposed valves, piping, and associated devices: Stainless steel.

E. Test Kit for Emergency Shower and Safety Stations:
1. Provide 48 inch telescopic aluminum pole, 11-1/2 inch diameter Tyvek test chute, 5 gallon plastic pail and eyewash tester.

F. Deck Mounted Eye, Face and Body Spray Units:
1. Dual purpose eyewash/drench hose unit.
2. The angled dual head body and valve of forged brass.
3. The squeeze handle of stainless steel with plastic cover.
4. The handle and deck flange of molded nylon, with handle locater guides.
5. Provide self-closing valve with a locking clip to hold the valve open once the unit is activated.
6. Provide unit with dual, polypropylene, angled, gentle spray heads; polyurethane filter; integral volume control; integral backflow preventer; and integrated nylon flip-top dust cover.
7. Finish: Match laboratory service fitting finish.
8. Provide with 8 foot long high pressure, reinforced PVC hose.

G. Thermostatic Mixing Valve
1. Provide at every emergency shower, eye wash or combination unit.
2. Provide with bimetallic thermostat that senses incoming water temperature and automatically blends water to a pre-set temperature.
3. Provide with fail safe option for loss of either hot or cold water. Loss of hot water, valve will continue to deliver cold water. Loss of cold water, valve will close and not deliver any water.
4. Include mounting bracket.
5. ASSE certified under Standard 1071.

2.13 UNDERCABINET/SHELVING TASK LIGHTING

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Description: UL1598, UL2108 and UL8750 listed, LED light fixture in lengths equal to the cabinet or shelf it is mounted to. Provide standard output, neutral white, color temp to match general room lighting color temp, minimum 90 CRI or higher, daisy chained together with integral individual dimming from 0 to 100 percent and rocker switch on each fixture. Provide with occupancy sensor and automatic shut-off after 10 hours in silver, anodized aluminum, or white finish.

C. Acceptable Manufacturers:
1. LightCorp; Model: Reed Premier “” Standard Output.
2. Mocha Lighting; Model: Lungo “” Low Voltage.
3. BOCA Flasher; Model: TASK Master.

2.14 UMBILICALS/SERVICE DROPS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Description: Construct of 18 gage sheet metal with collar at top. Provide bottom curb in same material as benchtop, properly cemented to benchtop. Provide top collar of 16 gage sheet steel. Provide 1 inch by 1 inch, 18 gage angle at curb.

C. Umbilicals shall have removable sections for easy access to piping and conduit. Exposed fasteners will not be allowed. Removal of sections shall not disturb ceiling or benchtop. Construct hanger clips of 18 gage sheet metal and spot welded to removable section.

D. On freestanding umbilicals provide a pipe support channel, spot welded to the fixed enclosure section. On wall or corner umbilicals, attach pipe support channel to the wall.
   1. Basis of Design: Unistrut

E. Finish: Finish as specified for metal finish in this section, with color selected by Owner's Representative.

2.15 OVERHEAD SERVICE CARRIERS (THE WING)

A. Description: Construct of metal framing system components in dimensions indicated in drawings. Provide service carriers pre-plumbed for required utilities and coordinate laboratory gas piping material with Division 22. Provide service carriers with receptacles and pre-wired for required electrical and data and coordinate requirements with Divisions 26/27. Coordinate connection of services, point exhaust, electrical and data and junction boxes with other trades.

B. Construct of 11 gage steel framing members with 18 gage metal closure panels. Bottom and end panels to be removable.

C. Securely and rigidly fasten the entire assembly, including diagonal braces, to structural slab above or to a structural grid where provided.

D. Ceiling Trim Plate: Provide ceiling trim plate at each vertical support that penetrates the ceiling system.

E. Finish assembly as specified for metal finish in this section. Paint all exposed piping and conduit servicing the carrier. Color selected by Owner's Representative.

2.16 GAS CYLINDER RESTRAINTS

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

B. Description: Provide metal framing system members, fastened to the wall or laboratory bench, for mounting of cylinder restraint devices.

C. Metal Framing System Components: Consist of two 12 gage steel channel members with two male swivel hanger fittings, Number M2350, on each member for each cylinder. Unistrut Part Numbers are referenced. Finish as specified for metal finish in this section, with color selected by Owner's Representative.
   1. Acceptable Manufacturers:
      a. Unistrut Corporation
      b. Elcen
      c. Grinnell Power Strut

D. Chain Restraints: Consist of 3/16 inch diameter Type 316 stainless steel chain Number 3618T715, length as required to restrain a standard 9 or 10 inch gas cylinder, with a Type 316 stainless steel threaded connector Number 3711T33, on one end of the chain, and a Type 316 stainless steel load rated spring snap with a minimum load rating of 300 pounds, Number 8907T11, on the other end of the chain.
   1. Acceptable Manufacturer /Distributer:
      a. McMaster-Carr.

2.17 SOURCE QUALITY CONTROL TESTING OF METAL FINISH

A. Metal Finish: Meet or exceed the latest edition of the following Section and Articles of SEFA-8-M Recommended Practices;
   1. 8.0 Cabinet Surface Finish Tests"
      a. 8.1 Chemical Spot Test.
      b. 8.2 Hot Water Test.
      c. 8.3 Impact Test.
      d. 8.4 Paint Adhesion Test.
      e. 8.5 Paint Hardness Test.

B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.

C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-8-M Recommended Practices.

2.18 SOURCE QUALITY CONTROL TESTING OF EPOXY WORK SURFACES

A. Meet or exceed the latest edition of the following Section and Articles of SEFA-3 Recommended Practices:
   1. 2.1 Chemical/Stain Resistance Test:
      a. Test Method A.
      b. Test Method B.

B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.

C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-3 Recommended Practices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 DELIVERY

A. Delivery casework systems in two stages:
   1. Deliver fixed casework and fume hoods.
   2. Deliver flexible casework systems.

B. Deliver flexible casework systems just prior to building occupancy, as instructed by Architect.

3.3 PREPERATION

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.4 INSTALLATION

A. General:
   1. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified.
      a. Respective manufacturer/fabricator's written installation instructions.
      b. Approved submittals.
      c. Contract Documents.
   2. Control of Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.
   3. Install casework, tables, casework support systems, overhead service drops, fume hoods and local point exhaust devices in accordance with manufacturer's instructions and approved Shop Drawings, and under the supervision of the manufacturer's trained personnel.
      a. Include installation of service fixtures. Final connections to services are specified in Division 22.

   4. Anchor casework and fume hoods securely in place with appropriate seismic tie-down kits, in accordance with delegated design calculations and requirements.

B. Casework Installation:
   1. Install, plumb, level, true and straight with no distortions. Shim as required, using concealed shims. Securely anchor to building structure. Where laboratory furniture abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.

2. Installation of each individual bench run shall start at the high point of the floor under that bench run with levelers screwed in as much as possible.
3. Where required, assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
4. At fixed casework installations provide galvanized backer plates at toe kicks to receive applied base where floor elevation deviations cause gaps over one inch between bottom of cabinet base and floor.
5. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by Manufacturer.
6. Securely fasten tall cabinets, fume hood superstructures and tall flammable storage cabinets to solid support material near top of cabinet.
7. Reinforcement of stud walls to support cabinets, shelving, and other wall mounted laboratory furnishing items: Done during wall erection by trade involved. Laboratory furniture company/supplier is responsibility for indicating on Shop Drawings the accurate location and sizing of reinforcement.

C. Work Surface Installation:
1. Field jointing where practicable: Made in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by Manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so that there is no job site processing of top and edge surfaces.
2. Abut top and edge surfaces in 1 true plane, with internal supports placed to prevent any deflection.
3. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Prior to making openings, verify size of opening with actual size of equipment to be used. Form inside corners to a radius of not less than 1/8 inch. After sawing, rout and file cutouts to ensure smooth, crack free edges. Seal exposed edges after cutting with a waterproofing material recommended by manufacturer.
4. Secure tops to support with concealed Z-Type, angle type fastening, "Liquid Nails", Ply400/Ply 200 adhesive or equivalent. Fastening devices spaced no more than 3 feet on center. Adhesives shall be liberally applied for solid anchoring of tops.
5. Plastic laminate worktop joints: 1/4 inch diameter bolt type "dog-bone" or "tite-joint" fasteners routed into bottom surface of worktops. Provide flush hairline joints in top units and seal with silicone sealant.
6. Epoxy Resin Work Surface Joints: 3/32 inch flush and smooth with epoxy sealant.
7. Stainless Steel Work Surface joints: Electrically weld all shop and field joints; grind smooth and polish.
8. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.

D. Sink Installation: Set in chemical resistant sealing compound sinks which were not factory installed and secured and supported per manufacturer's recommendations.

E. Accessory Installation: Install accessories, fixtures and equipment in accordance with manufacturer's recommendations ready for final connection to services.

F. Refer to Specification Section 115313 for additional information regarding fume hood installation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer/Fabricator's Field Service: Manufacturer/fabricator's qualified technical representative shall inspect first day's Work and periodically inspect Work to ensure installation is proceeding in accordance with manufacturer/fabricator's designs, recommendations, instructions, and warranty requirements. Representative shall submit written reports of each visit indicating observations, findings, and conclusions of inspection.

B. Testing Agency Field Service: The Owner will engage through the Contractor a qualified independent testing agency to perform field quality control. Materials and installation failing to meet specified requirements shall be replaced at Contractor's expense. Retesting of materials and installations failing to meet specified requirements shall be done at Contractor's expense.

3.6 ADJUSTING

A. Repair or remove and replace defective work, as directed by Owner's Representative upon completion of installation.

B. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

3.7 CLEANING AND PROTECTION

A. Clean shop finished casework and fume hoods, touch up as required, and remove and refinish damaged or soiled areas.

B. Cover casework for protection against soiling and deterioration during remainder of construction period.

C. Clean countertops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

D. If steel wool is used in cleaning stainless steel, use only stainless wool.

E. Protect casework and fume hoods before, during, and after installation. Materials damaged due to improper protection are cause for rejection.

END OF SECTION

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Quartz agglomerate countertops.
   2. Quartz agglomerate backsplashes.
   3. Quartz agglomerate end splashes.
   4. Quartz agglomerate apron fronts.

B. Related Requirements:
   1. Section 017823 "Operation and Maintenance Data".

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:
   1. Product Data: Product Data: Environmental Product Declaration (EPD).
   2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
   3. Product Data: For adhesives, indicating VOC content.
   4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
   1. Show locations and details of joints.
   2. Show direction of directional pattern, if any.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:
   1. Countertop material, 6 inches square.
   2. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10 inches, of construction and in configuration specified.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 2 linear feet ~~(3 linear m)~~ for every 100 linear feet ~~(150 linear m)~~ or fraction thereof, of each type, color, pattern, and size of countertop product installed. **(Add. A)**

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
   1. Build mockup of typical countertop as indicated on Drawings.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of polymers, resins, and pigment and complying with ISFA 3-01.

B. Basis of Design (Product Standard): Contract Documents are based on products and systems indicated to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

C. Environmental Product Declaration: Provide Type III Product Specific Environmental Product Declaration with external verification in which the manufacturer is recognized as the participant by the program operator in accordance with ISO 14025, and EN15804 or ISO 21930 and that have at least a cradle to gate scope.
   1. Colors and Patterns: Match Architect's samples.

D. General Emissions Evaluation: Products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017. Evaluation must state the applicable exposure scenario, total VOC (TVOC) content range.

E. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

F. Plywood: Exterior Grade C-D Exposure 1 complying with DOC PS 1.

2.2 FABRICATION

A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
   1. Grade: Custom.

B. Configuration:
   1. Front: As indicated.
   2. Backsplash: As indicated.
   3. End Splash: As indicated.

C. Countertops: 3/4-inch- thick, quartz agglomerate with front edge built up with same material.

D. Backsplashes: 3/4-inch- thick, quartz agglomerate.

E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

F. Joints:
   1. Fabricate countertops without joints where possible.
   2. When joints are unavoidable, fabricate countertops in sections for joining in field.
      a. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
      b. Joint Type, Bonded: 1/32 inch or less in width.
      c. Joint Type, Sealant Filled: 1/16 inch in width.
      d. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.

G. Cutouts and Holes:
   1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
      a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
   2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
   3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
   4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by quartz agglomerate manufacturer.
   1. Adhesives shall have a VOC content of 70 g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

2.4 ACCESSORIES

A. Grommets for Cable Passage through Countertops: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Color: As selected by Architect.

B. Counter Support Brackets: Manufactured, wall mounted, heavy duty, welded aluminum brackets for supporting countertops and vanities.
1. Inside Wall Mounted Brackets:
a. Size: As recommended by manufacturer for counter depths indicated.
b. Finish: As selected by Architect.
1) Color: As selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate

manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
   1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
   2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.

H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
   1. Seal edges of cutouts in particleboard subtops by saturating with varnish.

I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

J. Countertop Support Brackets:
   1. Install support brackets in accordance with manufacturer's written instructions.
   2. Install brackets at locations and heights indicated on Drawings.
   3. Install brackets rigidly to supporting substrate so that they are secure, plumb, and aligned.

END OF SECTION

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

C. WOG: Water, oil, gas.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and soldered ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

1.5 MAINTENANCE MATERIAL SUBMITTALS (Add. A)

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one valve or rebuild kit for each size and type of valve. (Add. A)

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections
8. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Type:
1. Gear Actuator: For quarter-turn valves NPS 4and larger.
2. Hand Lever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:
1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Threaded or Soldered Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. WATTS.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.

5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

B. Bronze Ball Valves, Three Piece with Full Port and Stainless Steel Trim, Threaded Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. DynaQuip Controls.
c. NIBCO INC.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

2.4 STAINLESS STEEL BALL VALVES

A. Stainless Steel Ball Valves, Two Piece with Full Port, Threaded or Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. A.Y. McDonald Mfg. Co.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Bray International, Inc.
d. FNW; Ferguson Enterprises, Inc.
e. Jomar Valve.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support to piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.
   7. For Stainless Steel Piping, NPS 2 and Smaller: Threaded ends.
   8. For Stainless Steel Piping,NPS 2-1/2to NPS 4: Flanged ends.
   9. For Stainless Steel Piping,NPS 2 and Smaller: Press ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze ball valves, two piece with full port, and stainless steel trim. Provide with threaded solder-joint ends.
   2. Bronze ball valves, three piece with full port, and stainless steel trim.

END OF SECTION

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Iron, single-flange butterfly valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one valve or rebuild kit for each size and type of valve. (Add. A)

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.

2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

H. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. WATTS.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. WATTS.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating, NPS 12 and Smaller: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2-1/2 and Larger:
1. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze disc.

3.5 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG

A. Pipe NPS 2-1/2 and Larger:
1. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze disc.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM NBR seat, aluminum-bronze disc.

END OF SECTION

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze lift check valves.
   2. Bronze swing check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one valve or rebuild kit for each size and type of valve. (Add. A)

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 Annex G and NSF 372.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane; Crane Energy Flow Solutions.
   b. Jenkins Valves; Crane Energy Flow Solutions.
   c. Stockham; Crane Energy Flow Solutions.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded or soldered. See valve schedule articles.
   f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NIBCO INC.
   b. WATTS.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded or soldered. See valve schedule articles.
   f. Disc: NBR, PTFE.

2.3 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. NIBCO INC.
      b. WATTS.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded or soldered. See valve schedule articles.
      f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. NIBCO INC.
      b. WATTS.
   2. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded or soldered. See valve schedule articles.
      f. Disc: PTFE.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Check Valves: In horizontal or vertical position, between flanges.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
      c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
   3. For Copper Tubing, NPS 5 and Larger: Flanged.
   4. For Steel Piping, NPS 2 and Smaller: Threaded.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
   6. For Steel Piping, NPS 5and Larger: Flanged.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
   1. Vertical, Upflow Applications Only: Bronze lift check valves with bronze disc, Class 125, with soldered or threaded end connections.
   2. Horizontal and Vertical Applications: Bronze swing check valves with bronze nonmetallic disc, Class 125, with soldered or threaded end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron swing check valves withnonmetallic-to-metal seats, Class 125, with threaded or flanged end connections.
   2. Iron, grooved-end swing check valves, 300 CWP.
   3. Iron, dual-plate check valves with metal resilient seat, Class 125 , with threaded or flanged end connections.

4. Iron, single-plate check valves with resilient seat, Class 125, with threaded or flanged end connections.

3.6 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG

A. Pipe NPS 2 and Smaller:
   1. Vertical, Upflow Applications Only: Bronze lift check valves with bronze nonmetallic disc, Class 125, with soldered or threaded end connections.
   2. Horizontal and Vertical Applications: Bronze swing check valves with bronze nonmetallic disc, Class 125, with soldered or threaded end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron swing check valves with metal nonmetallic-to-metal seats, Class 125, with threaded or flanged end connections.
   2. Iron, grooved-end swing check valves, 300 CWP with threaded or flanged end connections.
   3. Iron, dual-plate check valves with metal resilient seat, Class 125 , with threaded or flanged end connections.

3.7 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze swing check valves with bronze disc, Class 125, with soldered end connections.
   2. Bronze swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron swing check valves with metal seats, Class 125, with threaded or flanged end connections.

C. CPVC Pipe NPS 4 and Smaller: CPVC ball check valve.

END OF SECTION

SECTION 220523.15 - GATE VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze gate valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one valve or rebuild kit for each size and type of valve. (Add. A)

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSP 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. RS Valves in Insulated Piping: With 2-inch stem extensions.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Flow Controls; Conbraco Industries, Inc.
      b. NIBCO INC.
      c. WATTS.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.
      c. Body Material: Bronze with integral seat and screw-in bonnet.
      d. Ends: Threaded or solder joint.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Flow Controls; Conbraco Industries, Inc.
      b. NIBCO INC.
      c. WATTS.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 200 psig.
      c. Body Material: Bronze with integral seat and screw-in bonnet.
      d. Ends: Threaded or solder joint.

e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copper tube and fittings - domestic water.
   2. Piping joining materials - domestic water.
   3. Encasement for piping.
   4. Transition fittings - domestic water.
   5. Dielectric fittings - domestic water.

B. Related Requirements:
   1. Section 331415 "Site Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Copper tube and fittings - domestic water.
   2. Piping joining materials - domestic water.
   3. Encasement for piping.
   4. Transition fittings - domestic water.
   5. Dielectric fittings - domestic water.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flanged Fitting Gaskets: Equal to 5 percent of amount of each type and size installed. (Add. A)

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking

Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Drawn-Temper Copper Tube: ASTM B88, Type K,ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K,ASTM B88, Type L.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.

E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.

F. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

G. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. NIBCO INC.
      c. Viega LLC.
   2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
   3. Housing: Copper.
   4. O-Rings and Pipe Stops: EPDM.
   5. Tools: Manufacturer's special tools.
   6. Minimum 200 psig working-pressure rating at 250 deg F.
   7. Lead-free requirements of NSF-61-372 through testing under NSF/ANSI/CAN 372

2.4 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Must comply with California AB1953.

D. Flux: ASTM B813 2010, water flushable. Must comply with California AB1953.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Viking Johnson.
2. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jomar Valve.
   b. WATTS; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.
2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE 1079.
4. Pressure Rating: 125 psig minimum at 180 deg F 150 psig 250 psig Insert value.
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. GF Piping Systems: Georg Fischer LLC.
   b. Matco-Norca.
   c. Zurn Industries, LLC.
2. Source Limitations: Obtain dielectric flanges from single manufacturer.

3. Standard: ASSE 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: 125 psig minimum at 180 deg F 150 psig 175 psig 300 psig Insert value.
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller is to be the following:
1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger is to be the following:
1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

F. Under-building-slab, domestic water piping, NPS 2 and smaller is to be the following:
1. Drawn-temper or annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 and smaller is to be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure seal joint fittings; and pressure sealed joints.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 is to be the following:
1. Drawn-temper copper tube, ASTM B88, Type L; copper, solder-joint fittings; and brazed joints.

I. Aboveground domestic water piping, NPS 5 to NPS 8, is to be the following:
1. Drawn-temper copper tube, ASTM B88, Type L; copper, solder-joint fittings; and brazed joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement in accordance with ASTM A674 or AWWA C105/A21.5.

E. Install valves in accordance with the following:
1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. 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.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gauges for Plumbing Piping."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gauges for Plumbing Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or .

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper tubeand pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of copper tube and pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system in accordance with either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.
   3. After purging and disinfecting, maintain facility water system according to the facility water management plan until building turnover.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Piping Inspections:
    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
    a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Water-hammer arresters.
6. Flexible connectors.
7. Water meters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide one spare or rebuild kit for each size and type of vacuum breaker, backflow preventer, water pressure-reducing valve, or balancing valve. (Add. A)

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Woodford Manufacturing Company.
      c. Zurn Industries, LLC.
   2. Standard: ASSE 1011.
   3. Body: Bronze, nonremovable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1020.
   3. Accessories:
      a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Woodford Manufacturing Company.
      c. Zurn Industries, LLC.
   2. Standard: ASSE 1035.
   3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
   4. Body: Bronze.
   5. End Connections: Threaded.
   6. Finish: Chrome plated.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   4. Body: Bronze.

B. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1013.
   3. Operation: Continuous-pressure applications.
   4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
   5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

C. Double-Check, Backflow-Prevention Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1015.
   3. Operation: Continuous-pressure applications unless otherwise indicated.
   4. Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
   5. Accessories:
      a. ValvesNPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
      b. ValvesNPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Watts; a Watts Water Technologies company.
      b. Zurn Industries, LLC.
   2. Standard: ASSE 1022.
   3. Operation: Continuous-pressure applications.
   4. Body: Stainless steel.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
   a. Watts; a Watts Water Technologies company.
   b. Zurn Industries, LLC.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
   a. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Body: Stainless steel.
5. End Connections: Threaded.

G. Reduced-Pressure-Detector, Fire-Protection, Backflow-Preventer Assemblies
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Ames Fire & Waterworks.
   b. Watts; a Watts Water Technologies company.
   c. Zurn Industries, LLC.
3. Standard: ASSE 1047 and is FM Global approved or UL listed.

H. Double-Check, Detector-Assembly Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
   a. Watts; a Watts Water Technologies company.
   b. Zurn Industries, LLC.
2. Standard: ASSE 1048 and is FM Global approved or UL listed.
3. Operation: Continuous-pressure applications.

I. Hose-Connection Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
   a. Watts; a Watts Water Technologies company.
   b. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :

a. Watts; a Watts Water Technologies company.
b. Zurn Industries, LLC.

2. Standard: ASSE 1003.
3. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
4. Valves for Booster Heater Water Supply: Include integral bypass.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water-Control Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
a. Watts; a Watts Water Technologies company.
b. Zurn Industries, LLC.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
a. NIBCO Inc.
b. Watts; a Watts Water Technologies company.

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Memory-Stop Balancing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following
a. Milwaukee Valve Company.
b. NIBCO Inc.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
a. Leonard Valve Company.
b. Powers; a division of Watts Water Technologies, Inc.
c. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.

B. Primary, Thermostatic, Water Mixing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :

a. Lawler Manufacturing Company, Inc.
b. Leonard Valve Company.
c. Powers; a division of Watts Water Technologies, Inc.
2. Standard: ASSE 1017.

C. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by the following
a. Powers.
b. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
a. Acorn Engineering Company.
b. IPS Corporation.
c. Oatey.
d. Watts; a Watts Water Technologies company.
2. Mounting: Recessed.

B. Icemaker Outlet Boxes :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
a. Acorn Engineering Company.
b. IPS Corporation.
c. Oatey.
2. Mounting: Recessed.

2.10 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Precision Plumbing Products, Inc.
      b. Sioux Chief Manufacturing Company, Inc.
      c. Smith, Jay R. Mfg. Co.
   2. Standard: ASSE 1010 or PDI-WH 201.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following :
   1. Flexicraft Industries.
   2. Metraflex Company (The).

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.13 WATER METERS

A. Displacement-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Mueller Co.
      b. Sensus.
   2. Description:
      a. Standard: AWWA C700.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: Nutating disc; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. End Connections: Threaded.

B. Turbine-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Badger Meter, Inc.

b. Mueller Co.
c. Sensus.

2. Description:
   a. Standard: AWWA C701.
   b. Pressure Rating: 150-psig working pressure.
   c. Body Design: Turbine; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility company.
   e. Case: Bronze.
   f. End Connections for Meters NPS 2 and Smaller: Threaded.
   g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following :
      a. Badger Industries, Inc.
      b. Mueller Co.
      c. Sensus.
   2. Description:
      a. Standard: AWWA C702.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: With integral mainline and bypass meters; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. Pipe Connections: Flanged.

D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water mixing-valve assemblies.
13. Photographic-process, thermostatic, water mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. In-line, sealless centrifugal pumps.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one pump and two rebuild kits for each pump size and type. (Add. A)

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
   1. Armstrong Pumps Inc.
   2. Bell & Gossett; a Xylem brand.
   3. Grundfos Pumps Corp.
   4. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:
   1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
   2. Casing: Bronze, with threaded or companion-flange connections.
   3. Impeller: Stainless Steel.
   4. Motor: Single speed, unless otherwise indicated.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   1. Type: Water-immersion temperature sensor, for installation in piping.
   2. Range: 50 to 125 deg F .
   3. Enclosure: NEMA 250, Type 4X.
   4. Operation of Pump: On or off.
   5. Transformer: Provide if required.

B. Timers: Electric, for control of hot-water circulation pump.
   1. Type: Programmable, seven-day clock with manual override on-off switch.
   2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
   3. Operation of Pump: On or off.
   4. Transformer: Provide if required.
   5. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days .

C. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
   1. Type: Adjustable time-delay relay.
   2. Range: Up to five minutes.
   3. Setting: Five minutes.

4. Enclosure: NEMA 250, Type 4X .
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

D. Install pressure switches in water supply piping.

E. Install thermostats in hot-water return piping.

F. Install timers on wall in engineer's office.

G. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
   a. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section

220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."

1. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

E. Connect pressure switches, thermostats, time-delay relays, and timers to pumps that they control.

F. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 223100 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial water softeners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water softeners.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Wiring Diagrams: For power, signal, and control wiring.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of mineral and brine tanks.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
      d. Attrition loss of resin exceeding 3 percent per year.
      e. Mineral washed out of system during service run or backwashing period.
      f. Effluent turbidity greater and color darker than incoming water.
      g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.

1.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide three months' full maintenance by skilled employees of water softener Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 1000 lb. Deliver on pallets. (Add. A)

PART 2 - PRODUCTS

2.1 COMMERCIAL WATER SOFTENERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Marlo Incorporated.
2. EasyWater

B. Description: Factory-assembled, pressure-type water softener. Provide a sodium cycle, cation exchange, automatic regenerating water softening system.

C. System must include:
1. Three 48”x72 FRP resin tanks in a parallel/progressive format
2. One 50”x60” brine tank
3. 3" metered, programmable, and pre-programmed electronic controls valves that have a 125psi rating
4. System shall have a blend valve installed to blend the softened water to 3-4 grains per gallon of hardness
5. System shall be skid mounted with automotive grade corrosion resistant paint, pre-plumbed (3” sch. 80 PVC with a 6” in/out header), pre-wired and capable of accepting a single electrical source
6. Standard: Comply with NSF 61 Annex, "Drinking Water System Components - Health Effects."
7. Configuration: Triple unit with three mineral tanks and one brine tank.
8. Mounting: On skids.

PART 3 - EXECUTION

3.1 WATER SOFTENER INSTALLATION

A. Equipment Mounting:
1. Install commercial water softeners 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 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to equipment, allow space for service and maintenance of equipment.

C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
1. Metal general-duty valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 " and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Plastic valves are specified in Section 221116 "Domestic Water Piping."

3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

D. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
1. Exception: Water softeners with factory-installed pressure gages at locations indicated.

2. Exception: Water softeners in hot-water service.

E. Install valved bypass in water piping around water softeners.
1. Metal general-duty valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Plastic valves are specified in Section 221116 "Domestic Water Piping."
3. Water piping is specified in Section 221116 "Domestic Water Piping."

4. Exception: Water softeners in hot-water service.

F. Install drains as indirect wastes to spill into open drains or over floor drains.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water softeners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

B. Add water to brine tanks and fill with the following form of salt:
   1. Commercial Water Softeners: Processed, plain salt pellets.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   1. ASTM D 859, "Test Method for Silica in Water."
   2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   3. ASTM D 1068, "Test Methods for Iron in Water."
   4. ASTM D 1126, "Test Method for Hardness in Water."
   5. ASTM D 1129, "Terminology Relating to Water."
   6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners.

END OF SECTION

SECTION 223200 - DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Sections Includes:
   1. Building Water Filtration System (WT-2).
   2. Site Ultrafiltration System - Add Option 01

1.2 PROJECT CONDITIONS

A. Feedwater Analysis: From 8" Main "Well"
   1. Total Alkalinity: 260.0 mg/L
   2. Conductivity: 454.0 uS/cm.
   3. Bacteria: 0 cfu/mL.
   4. Color and Turbidity: Clear without sediment.
   5. Aluminum: 0.06 mg/L.
   6. Chloride: 5.60 mg/L.
   7. Copper: Not Detected.
   8. Hardness: 208.1 mg $CaCO_3$/L
   9. Iron: 0.08 mg/L.
   10. Manganese: 0.01 mg/L.
   11. Nitrate: Less than 0.50 mg/L.
   12. Phosphate: Non Detected
   13. Sulfate: 53.57 mg/L.
   14. Silicate: 9.65 mg/L.
   15. Zinc: 0.02 mg/L.

B. Feedwater Analysis: From 12" Main "Mixed Surface/Well"
   1. Total Alkalinity: 192.5 mg/L
   2. Conductivity: 398.0 uS/cm.
   3. Bacteria: 0 cfu/mL.
   4. Color and Turbidity: Clear without sediment.
   5. Aluminum: 0.10 mg/L.
   6. Chloride: 4.49 mg/L.
   7. Copper: Not Detected.
   8. Hardness: 184.7 mg $CaCO_3$/L
   9. Iron: 0.07 mg/L.
   10. Manganese: 0.03 mg/L.
   11. Nitrate: Less than 0.50 mg/L.
   12. Phosphate: Not Detected
   13. Sulfate: 74.38 mg/L.
   14. Silicate: 10.97 mg/L.
   15. Zinc: 0.03 mg/L.

1.3 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided.

1.4 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace water filtration components that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period of major components are not limited to, the following periods:
      a. Filtration Tank(s) excluding the filtration media to be warranted for a period of (5) years.
      b. Backwashing filtration valve(s) body to be warranted for a period of (5) years.
      c. Backwashing filtration electronic control boards, including motors, switches, and internal moving sealing parts to be warranted for a period of (1) year.
      d. Ultraviolet disinfection UV chamber to be warranted for a period of (2) years.
      e. Ultraviolet lamps, sleeves, and sensors to be warranted for a period of (1) years.
      f. No-Salt Conditioner to be warranted for a period of (5) years.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one pump and two rebuild kits for each pump size and type.
   2. Provide one filter for each filter size and type.
   3. Provide one membrane for each membrane size and type.
   4. Provide one valve or rebuild kit for each size and type of valve.
   5. Provide one controller, sensor, and actuator, for each type of controller, sensor, and actuator. (Add. A)

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of water filtration equipment through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Domestic water filtration equipment intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.3 WATER TREATMENT SYSTEM (TAG: WT-2)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. EasyWater, Inc.

B. Description: Complete system includes
   1. 500gpm sub-micron and self-backwashing filtration with one pass.
   2. 500gpm stainless and monitored ultraviolet (UV) sanitization.
   3. Electronic descaling system treatment before and after UV treatment for all domestic cold water. Electronic descaling technology must include pre-wrapped and pre-flanged PVC treatment spools and control panels with heat dissipating fins.
   4. Electronic descaling systems treatment required for all domestic hot water circulating loops and building hot water returns. Electronic descaling technology must include pre-wrapped and pre-flanged PVC treatment spools and control panels with heat dissipating fins.
   5. Skid mounted, pre-piped and pre-wired.

C. If Add Option 01 is accepted, water treatment (WT-2) will not be required.

2.4 ULTRAFILTRATION MEMBRANE TREATMENT SYSTEM (PUMP HOUSE ONLY) - ADD OPTION 01

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. WesTech Engineering LLC

B. Description:
   1. The ultrafiltration system shall be

C. Warranty:
   1. Mechanical Warranty: A mechanical warranty shall be provided for all mechanical equipment specified in this section. The warranty shall be for a minimum period of one year from start-up or 18 months from time of equipment shipment, whichever comes first. Such warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service.
   2. Module Warranty: A module warranty shall be provided for the system modules. The warranty shall be for a minimum of five years from equipment shipment. The first two years of the warranty shall be absolute and the last three shall be prorated. The prorated replacement cost is determined as the number of months in service multiplied by the membrane replacement price (supplied with the bid) and divided by the number of months of the warranty (60 months). Modules replaced under warranty will assume the remaining warranty period of the original module.

D. Ultrafiltration Skid:
   1. Description: Pumps (feed, backwash) and cleaning equipment (chemical metering pumps, recirculation pump, heater) shall be designed to meet requirements for the entire membrane system, and must be mounted on a single

skid. The skids shall be factory tested prior to shipment. The skid shall be shop sandblasted to SSPC-SP10 / NACE 2 near white blast and shop coated with polyester epoxy powder coat, 3 – 5 mils DFT.

2. Piping: Train piping shall be Sch 80 PVC or HDPE. Membrane Supplier shall provide all piping located on the membrane skids.
3. Train Support Frame: Each train shall be fabricated of epoxy coated carbon steel plates and shapes and be designed to adequately support the membrane modules and piping.

E. Ultrafiltration Membrane:
1. Description: The UF system shall be based on use of dead-end, outside-in, hollow-fiber, backwashable ultrafiltration membrane modules. Approved ultrafiltration modules include TorayTM HFUG-2020HN.
2. Modules:
   a. Shall ave a minimum of 969 square feet of filtration area.
   b. Shall be NSF 61 certified.
3. Membrane Materials:
   a. Shall be hollow fiber
   b. Shall have a maximum nominal pore size no greater than 0.01 micron.
   c. Manufacturered with PVDF
   d. Shall be compatible with cleaning chemicals like sodium hypochlorite and citric acid. pH exposure range shall be a minimum of 1-10.

F. Feed/CIP Pumps:
1. Description: Skid mounted feed/CIP pump. Pump shall be closed-coupled, end-suction centrifugal as manufactered by Goulds.
2. Controls: VFD in the UF control panel to maintain constant flow independent of the changing transmembrane pressure.
3. Motor: Shall be a TEFC premium efficiency inverter duty rated unit.

G. Prestrainers:
1. Description: An automatically backwashing inlet prestrainer shall be provided and skid-mounted on each train, and manufactured by Valve and Filter.
2. Removes all particles larger than 200 micron.
3. Capable of continuing to process forward flow during flushing cycle.
4. Stainless steel construction
5. Supplied with face piping, isolation valves, supports, and cleaner device.

H. Backwash Pump:
1. Description: A closed-coupled, end-suction centrifugal pump shall be provided and skid-mounted as manufactured by Goulds.
2. Construction: 316L stainless steel construction.
3. Controls: VFD in the UF control panel to maintain constant flow independent of the changing transmembrane pressure.
4. Motor: Shall be a TEFC premium efficiency inverter duty rated unit.

I. Compressed Air System:
1. Description: Two single stage, fluid injected air compressor with coalescing filters/regulators, and refrigerated air dryer shall be supplied to produce oil/water free air for the membrane backwash, air integrity testing and valve actuation.

2. Manufacturer: Quincy
3. Air compressor system shall be supplied with:
    a. Motor starter
    b. Pressure switch
    c. Pressure gauge
    d. Pressure relief valve
    e. Shut-off valve
    f. Receiver tank
4. Type: Reciprocating Air Compressor
5. Redundancy: N+1
6. PSIG: 100 psig working pressure
7. Noise: 70 dBA when measured 3 feet from equipment

J. Direct Membrane Integrity Test System:
1. Description: Membrane testing system to verify the integrity of the membrane modules.
2. Compressed air utilized to verify integrity & controlled by system's control system.
3. Provide provisions to visually confirm the results of the test and to allow identification of any faulty membrane module.
4. Direct Integrity Testing must be applied in such a manner that a 3 µm breach results in a test response, and the system must be capable of verifying the log-removal credit granted by the State or claimed by the manufacturer.

K. Instrumentation:
1. Description: On-line analytical measurement devices shall be included with measurements continously recorded and monitored by the membrane filtration PLC.
    a. Magnetic Flow Meters
        1) Flow meter type: Bidirectional Type
        2) Manufactrer: Siemens Magflo Series Mag 5000/5100W or approved equal.
        3) Epoxy carbon steel housing
        4) Provide a 4-20mA output to the PLC.
    b. Turbidimeters
        1) Manufacturer: Hack TU5300 or approved equal.
        2) Shall be provided with Hach sc4500 controller, isolations valves and mounting supports.
        3) Provide a 4-20mA output to the PLC.
    c. Pressure Transmitters
        1) Manufacturer: Trerice or approved equal.
        2) Provide pressure transmitters for operation integrity testing and performance monitoring for feed, filtrate, and transmembrane pressure.
    d. Level Transmitters
        1) Manufacturer: Trerice or approved equal.
        2) Provide for the feed and backwash tanks.
        3) Provide a 4-20mA output to the PLC.

L. Clean-In-Place Equipment:
1. Description: The CIP solution tank, heater, instrumentation, chemical dosing pumps, recirculation pump, and instrumentation shall be incorporated into the single ultrafiltration system skid and is required to be fully-automated upon HMI initiation by the operator.
2. Material of Construction: PVC or HDPE - Compatible with sodium hypochlorite and citric acid solutions.
3. Equipment:
   a. Solution Tank
      1) Description: CIP solution tank shall be a closed top, white translucent HDPE tank of sufficient size to manage recirculation of the CIP solution.
      2) Supplied connections for the drain, heating element, level transmitter, CIP recirculation pump, chemical injection, sample tap, and temperature transmitter.
   b. Recirculation Pump
      1) Description: Frame mounted, horizontal centrifugal pump with stainless steel housing impeller and shaft.
      2) Supplied with pressure gauges and valves.
   c. Solution Heater
      1) Description: Electric solution heater to be supplied per train.
      2) Manufacturer: Chromalox or approved equal.
      3) Number of heaters per train: Three (3)
      4) Electric Requirements: 5 KW per heater
      5) Heater shall be compatible with the CIP chemicals.
   d. Temperature Transmitters
      1) Description: Two temperature transmitters shall be supplied per train.
      2) Manufacturer: GF Signet, Dwyer or approved equal.
      3) Operating Range: -10º to +100º C
      4) Provide a 4-20mA output to the PLC.
   e. Level Transmitters
      1) Manufacturer: Trerice or approved equal.
      2) Provide at each CIP tank.
      3) Provide a 4-20mA output to the PLC.
   f. pH Sensor
      1) Manufacturer: GF Signet or approved equal.
      2) Operating Range: 0-14 pH units
      3) Provide a 4-20mA output to the PLC.
   g. Chemical Cleaning Metering Pumps
      1) Description: All necessary metering pumps shall be supplied for feeding liquid citric acid and sodium hypochlorite from chemical totes into the CIP solution tank.
      2) Manufacturer: Prominent or approved equal.
      3) Pumps:
         a) Solenoid or motor driven
         b) Positive discplacement pumps
      4) Provide with heads, diaphragms, check valves, foot-valves and isolations valves all compatible with the solution being pumped.

5) Controlled by UF electrical panel.
6) Shelf to be provided on skid to support metering pumps above the chemical storage totes.

M. Ultrafiltration Control System:
1. Description: ultrafiltration system will be supplied with one (1) Master PLC panel to control the membrane equipment. Each ultrafiltration skid will include one (1) electrical enclosure for storing RIO and VFDs.
2. Master PLC Panel:
a. Rating: NEMA 4
b. Construction: Painted mild steel skid mounted enclosure
c. Breaker: Operated externally via a rotary disconnect handle located on the enclosure door.
d. Filter Control System: Manufacturered in UL608A/698 certified panel shop
e. Display: 15" Advantech Panel PC graphical operator interface shall be provided.
f. I/O Connections:
1) Provide 20% spare input/output pre-wired out to the terminal strip for future for plant integration.
2) PLC to incorporate proper quantities of the following components:
a) PLC processor with Ethernet communications
b) 16 point, 120 volt discrete input card.
c) 16 point, Relay discrete output card.
d) 8 channel, analog input card.
e) 8 channel, analog output card.
f) PLC end terminator module.
3. Local Control Panel:
a. Rating: NEMA 4
b. Construction: Skid-mounted 304SS enclosure
c. Control Panel Includes:
1) Two (2) Schneider Electric Altivar VFDs with input line reactors for the feed and backwash pumps
2) 24 VDC power supply
3) Fuses and fuse blocks
4) Terminal blocks
5) Other supporting hardware
6) Manifold system to distribute the required service air to the appropriate skid mounted automated valves.
a) Provide with proper quantities of solenoid valves for 120 VAC.
b) Provide combination regulator/filter within control panel to ensure that clean air is supplied to the manifold.
c) Both sides of the solenoid valve manifold shall be supplied with pressurized air to ensure even distribution and that there is no loss of air pressure through the manifold.
d. Controls:
1) Allows for automatic control of all functions of the ultrafilter process. There shall also be manual control of all equipment via the operator interface.

2) Allows for integration with the existing equipment onsite and shall have the ability to interface with the existing level instrumentation.

N. Valves:
1. The following valves shall be supplied:
a. Automatic Butterfly Valves:
1) Manufacturer: Bray
2) Model: Series 3L
3) Description: Lug style with ductile or cast iron bodies, nylon coated ductile disc and stainless stem, EPDM seats and hand level operator.
4) Solenoids to be provided and mounted on solenoid manifold in the control panel and actuator shall be double acting.
b. Manual Butterfly Valves:
1) Manufacturer: Bray
2) Model: Series 3L
3) Description: Lug style with ductile or cast iron bodies, nylon coated ductile disc and stainless stem, EPDM seats and hand level operator.
c. Stainless Steel Ball Valves:
1) Manufacturer: Flow-Trek or approved equal.
2) Body: Stainless Steel
3) Socket welded connections
4) PTFE Seal
d. PVC Ball Valve:
1) Manufacturer: Spears or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of .

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls and floors for suitable conditions where will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT MOUNTING

A. Equipment Mounting: Install on concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
1. 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.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service for .
1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service, Including Testing: Engage a factory-authorized service representative to support field tests and inspections.

C. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain .

END OF SECTION

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water coolers.
   2. Bottle filling stations.
   3. Fixture carriers.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
      b. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of fixture 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 wiring.

C. Sustainable Design Submittals:
   1. Product Data: For water consumption.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For remote water coolers, 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water coolers, bottle filling stations, to include in maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include servicing and adjustment of electronic-sensor fixtures.

1.5 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. **Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 5 of each.** **(Add. A)**

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees Installer agrees to repair or replace water coolers bottle filling stations that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of metals, metal finishes, and other materials beyond normal weathering use.

B. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:
   1. Drinking fountains, water coolers, bottle filling stations, and remote water coolers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 WATER COOLERS

A. Water Coolers - Semi-Recessed, Wall Mounted, Stainless Steel :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Halsey Taylor.
      b. Oasis International.
   2. Source Limitations: Obtain semi-recessed, wall-mounted, stainless steel, water coolers from single source from single manufacturer.
   3. Standards:
      a. NSF 61.
      b. NSF 372.
      c. ASME A112.19.3/CSA B45.4.
      d. ASHRAE 18.
      e. UL 399.
      f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. Bubbler: One, with adjustable stream regulator, located on deck.
   5. Control: Push bar.

6. Drain: Grid with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.
    a. Standards:
        1) NSF 42.
        2) NSF 53.
10. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
11. Support: Provide manufacturer's support frame attachment to substrate.
12. Water-Cooler Mounting Height: Standard.
13. Capacities and Characteristics:
    a. Cooled Water: 8 gph.
    b. Ambient-Air Temperature: 90 deg F.
    c. Inlet-Water Temperature: 80 deg F.
    d. Cooled-Water Temperature: 50 deg F.

B. Water Coolers - Recessed, Wall Mounted, Stainless Steel :
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Elkay.
    b. Halsey Taylor.
    c. Murdock Manufacturing; A Division of Morris Group International.
2. Source Limitations: Obtain recessed, wall-mounted, stainless steel, water coolers from single source from single manufacturer.
3. Standards:
    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.
    d. ASHRAE 18.
    e. UL 399.
    f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Type: Vandal resistant.
5. Bubbler: One, with adjustable stream regulator, located on deck.
6. Control: Push bar.

7. Glass filler.
8. Drain: Grid with NPS 1-1/4 tailpiece.
9. Supply: NPS 3/8 with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.
    a. Standards:
        1) NSF 42.
        2) NSF 53.

12. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
13. Ventilation Grille: Stainless steel, located below water cooler.
14. Support: Provide manufacturer's support frame attachment to substrate.
15. Water-Cooler Mounting Height: Accessible in accordance with ICC A117.1.
16. Capacities and Characteristics:
    a. Cooled Water: 8 gph.
    b. Ambient-Air Temperature: 90 deg F.
    c. Inlet-Water Temperature: 80 deg F
    d. Cooled-Water Temperature: 50 deg F.
    e. Electrical Characteristics:
        1) Volts: 120 V ac.
        2) Phase: Single.
        3) Hertz: 60 Hz.

2.3 BOTTLE FILLING STATIONS

A. Bottle Filling Station - Surface Wall Mounted, ABS/Stainless Steel Combination :
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Haws Corporation.
2. Source Limitations: Obtain surface wall-mounted, ABS/stainless steel combination, bottle filling stations from single source from single manufacturer.
3. Standards:
    a. NSF 61.
    b. NSF 372.
4. Type: Vandal resistant.
5. Cabinet: ABS/stainless steel combination.
6. Bottle Filler: Sensor activation, with 20-second automatic shutoff timer. Fill rate is 0.5 to 1.5 gpm.
7. Drain: Grid type with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
10. Filter: One or more water filters complying with capacity sized for unit peak flow rate.
    a. Standards:
        1) NSF 42.
        2) NSF 53.
11. Support: Provide manufacturer's mounting plate.
12. Electrical Characteristics:
    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. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

B. Bottle Filling Station - Recessed, Wall Mounted, ABS/Stainless Steel Combination :
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Haws Corporation.
   2. Source Limitations: Obtain recessed, wall-mounted, ABS/stainless steel combination, bottle filling stations from single source from single manufacturer.
   3. Standards:
      a. NSF 61.
      b. NSF 372.
      c. ASME A112.19.3/CSA B45.4
   4. Type: Vandal resistant.
   5. Cabinet: ABS/stainless steel combination.
   6. Bottle Filler: Sensor activation, with 20-second. Fill rate is 0.5 to 1.5 gpm.
   7. Drain: Grid type with NPS 1-1/4 tailpiece.
   8. Supply: NPS 3/8 with shutoff valve.
   9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
   10. Filter: One or more water filters with capacity sized for unit peak flow rate.
      a. Standards:
         1) NSF 42.
         2) NSF 53.
   11. Support: Provide manufacturer's frame attached to substrate.
   12. Bottle Filling Station Mounting Height: Accessible in accordance with ICC A117.1.
   13. Electrical Characteristics:
      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. Volts: 120 V ac.
      c. Phase: Single.
      d. Hertz: 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Install recessed drinking fountains and bottle filling stations secured to wood blocking in wall construction.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. . Install valve upstream from filter for drinking fountain, water cooler, and bottle filling station. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

C. Adjust electronic-sensor settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 226313 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Carbon dioxide piping, designated "medical carbon dioxide."
2. Helium piping, designated "medical helium."
3. Nitrogen piping, designated "medical nitrogen."
4. Nitrous oxide piping, designated "medical nitrous oxide."
5. Oxygen piping, designated "medical oxygen."

B. Owner-Furnished Material:
1. Owner will furnish gases for medical gas concentration testing specified in this Section.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen for healthcare facility patient care.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

C. Brazing certificates.

D. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

E. Field quality-control reports.

1.5 MAINTENANCE MATERIAL SUBMITTALS (Add. A)

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Quick Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets, for each gas service, equal to 10 percent but no fewer than five units.
2. D.I.S.S. Service Connections: Furnish complete medical gas pressure outlets and suction inlets complying with CGA V 5, for each gas service, equal to 10 percent but no fewer than five units.

3. **Provide one valve or rebuild kit for each size and type of valve.** **(Add. A)**

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, , seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

B. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

C. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

D. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
   1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
   1. Zone-Valve Boxes:
      a. Steel Box with Aluminum Cover:
         1) Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
            a) Allied Healthcare Products Inc.
            b) Amico Corporation.
            c) Ohio Medical Corporation.
            d) Pattons Medical. **(Add. A)**
      b. Steel Box with Stainless-Steel Cover:
         1) Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
            a) BeaconMedaes.
            b) Tri-Tech Medical.

2) Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves. Medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.Interior Finish: Factory-applied white enamel.
3) Cover Plate: Aluminum or stainless steel with frangible or removable windows.
4) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

C. Ball Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Allied Healthcare Products Inc.; Chemetron Division.
b. Amico Corporation.
c. BeaconMedaes.
d. Pattons Medical. (Add. A)
2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever type with locking device.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions an manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

D. Check Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Allied Healthcare Products Inc.; Chemetron Division.
b. Amico Corporation.
c. Pattons Medical. (Add. A)
2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

E. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Allied Healthcare Products Inc.; Chemetron Division.
b. Amico Corporation.
c. BeaconMedaes.
d. Pattons Medical. (Add. A)

2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
3. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4, ASTM B 819, copper tubing with NPS 1 minimum ball valve.
4. Safety Valve: Bronze-body pressure relief valve set at 75 or 80 psig.
5. Instrumentation: Pressure gage.

F. Safety Valves:
1. Bronze body.
2. ASME-construction, poppet, pressure-relief type.
3. Settings to match system requirements.

G. Pressure Regulators:
1. Stainless-steel body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
3. Manual pressure-setting adjustment.
4. Rated for 250-psig minimum inlet pressure.
5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 MEDICAL GAS SERVICE CONNECTIONS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Allied Healthcare Products Inc.; Chemetron Division.
2. Amico Corporation.
3. BeaconMedaes.
4. **Pattons Medical.** **(Add. A)**

B. General Requirements for Medical Gas Service Connections:
1. Suitable for specific medical gas pressure and suction service listed.
2. Include roughing-in assemblies, finishing assemblies, and cover plates.
3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
4. Recessed-type units made for concealed piping unless otherwise indicated.

C. Roughing-in Assembly:
1. Steel outlet box for recessed mounting and concealed piping.
2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
3. Double seals that will prevent gas leakage.
4. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

D. Finishing Assembly:
1. Brass housing with primary check valve.
2. Double seals that will prevent gas leakage.
3. Cover plate with gas-service label.

2.5 MEDICAL GAS MANIFOLDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. **Pattons Medical.** **(Add. A)**

B. Comply with NFPA 99 for high-pressure medical gas cylinders.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Central Control-Panel Unit:
   1. Weatherproof cabinet.
   2. Supply and delivery pressure gages.
   3. Electrical alarm-system connections and transformer.
   4. Indicator lights or devices.
   5. Manifold connection.
   6. Pressure changeover switch.
   7. Line-pressure regulator.
   8. Shutoff valves.
   9. Safety valve.

E. Manifold and Headers:
   1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
   2. Designed for 2000-psig minimum inlet pressure except nitrous oxide manifolds may be designed for 800 psig and carbon dioxide manifolds may be designed for 1500 psig.
   3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
   4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

F. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

G. Mounting: Wall with mounting brackets for manifold control cabinet and headers.

H. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

2.6 SIMPLEX SPECIALTY GAS MANIFOLDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. BeaconMedaes.
   2. Praxair Technology, Inc.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

D. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for 2000-psig minimum inlet pressure, cylinder-bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

E. Mounting: Wall with mounting brackets for manifold control cabinet and header.

F. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

2.7 DUPLEX SPECIALTY GAS MANIFOLDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Airgas, Inc.
2. BeaconMedaes.
3. Matheson Tri-Gas.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Central Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

D. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure, cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

E. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

F. Mounting: Wall with mounting brackets for manifold control cabinet and headers.

2.8 BULK MEDICAL GAS STORAGE TANKS

A. General Requirements for Bulk Medical Gas Storage Tanks:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Acme Cryogenics.

b. Chart Industries, Inc.

2. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1; and NFPA 99.
3. Include bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies.
4. Controls: Include actuating switch for alarm-system connection and means for automatic actuating of reserve supply.
5. Bulk Medical Gas Storage Tanks: Vertical mounted, double-wall construction with inner vessel fabricated according to ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for medical gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:
   a. Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
   b. Pressure Gages: For tank pressure and facility service-line pressure.
   c. Contents Gage: High- and low-level indicator with electric signal circuit connection.
   d. Drain Valves: For piping, inner vessel, and outer shell.
   e. Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
   f. Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
   g. Permanent label showing medical gas type, storage-tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.

2.9 GAS CYLINDER STORAGE RACKS

A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.

B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.10 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Fittings: If manufacturer-cleaned and -capped fittings is not available or if precleaned fittings must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas fittings of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
2. Wash medical gas fittings in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
   a. Scrub to ensure complete cleaning.
   b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were 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. Comply with NFPA 99 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and for branch connections.

K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

M. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

P. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

A. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or Type 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

3.7 IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   1. Carbon Dioxide: Black or white letters on gray background.
   2. Helium: White letters on brown background.
   3. Nitrogen: White letters on black background.
   4. Nitrous Oxide: White letters on blue background.
   5. Oxygen: White letters on green background or green letters on white background.

3.8 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
   2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
      a. Initial blowdown.
      b. Initial pressure test.
      c. Cross-connection test.
      d. Piping purge test.
      e. Standing pressure test for positive-pressure medical gas piping.
      f. Standing pressure test for vacuum systems.
      g. Repair leaks and retest until no leaks exist.
   3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
      a. Standing pressure test.
      b. Individual-pressurization or pressure-differential cross-connection test.
      c. Valve test.
      d. Master and area alarm tests.
      e. Piping purge test.
      f. Piping particulate test.
      g. Piping purity test.
      h. Final tie-in test.
      i. Operational pressure test.
      j. Medical gas concentration test.
      k. Medical air purity test.
      l. Verify correct labeling of equipment and components.
      m. Verify medical gas supply sources.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare test and inspection reports.

3.9 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.10 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.11 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Gas Piping except Medical Nitrogen Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.

C. Medical Nitrogen Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

D. Specialty Gas Piping except Specialty Gas Larger Than NPS 3and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.

E. Specialty Gas Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

F. Protective Conduit: PVC pipe, PVC fittings, and solvent-cemented joints.

3.12 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION

SECTION 232123 - HYDRONIC 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. Separately coupled, horizontally mounted, in-line centrifugal pumps.
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. ECM: Electronically commutated motor.

B. Buna-N: Nitrile rubber.

C. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
   1. Submitted pump curves shall include minimum, maximum, and furnished impellar data with operating point annotated for the scheduled pump speed. Pump curve data shall include capacities, heads, efficiencies, and brake horsepower throughout the entire range of the pump.
   2. Include separate curve to show performance at varying speeds when pump is equipped with a variable speed drive.
   3. Include separate combined pump curve to show performance when pumps are operating in parallel with another pump.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring. Differentiate between field and manufacturer installed wiring.

C. Delegated Design Submittals: For each pump.

   1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for pumps, 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 pumps to include in emergency, operation, and maintenance manuals.
   1. Include pump curves with O&M Data
   2. Include factory and field vibration testing reports (when required) with O&M Data

1.7 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.8 COORDINATION

A. Coordinate size and location of concrete bases and housekeeping pads. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate wiring between pump starter/vfd and pump motor with Division 23.

1.9 MAINTENANCE MATERIAL SUBMITTALS (Add. A)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. (Add. A)
   1. Mechanical Seals: One mechanical seal(s) for each pump. (Add. A)
   2. Motors: One spare motor for each size and type. (Add. A)

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and seismic restraints.

C. Seismic Performance: Pumps shall withstand the effects of earthquake motions determined in accordance with 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. Component Importance Factor: 1.5.

2.2 GENERAL PUMP REQUIREMENTS

A. Provide pumps with capacities and characteristics indicated on the Drawings. Pumps shall perform to the specific duty point for which they are intended.

B. Pumps shall be suitable for the fluid, temperature, and pressure. At a minimum, pumps shall have a rating suitable for 175 psig operating pressure and 200 F continuous water temperature.

C. Provide ASME B16.1 flanges on pumps with suction sizes 2" and larger. Rating to suit pressure of fluid pumped.

D. Provide motors and electrical devices in accordance with Section 220513.

E. Pumps shall motors that are non-overloading throughout their entire flow range.

F. Pumps shall have a ratio of 1.15 or higher maximum impeller diameter to the selected impeller diameter.

G. Pump / impeller combinations shall be the most efficient possible for the specified pump type. Pump efficiency shall be within 7 percentage points of the maximum efficiency on the specific impellar pump curve. The duty point shall be at a higher flow than the highest efficiency point on the curve and shall not be more than 85% of the end of curve flow.

H. Pump suction velocities shall not exceed 13 fps; except double suction pump suction velocities shall not exceed 15 fps.

I. Unless otherwise noted, provide internally flushed mechanical seal system with carbon face seal rotating against a ceramic face. Seal system shall be leakless and compatible with the pumped fluid type, pressure, and temperature. Seal systems for pumps handling glycol based heat transfer fluids shall be specifically rated for glycol service.

J. Unless otherwise noted, provide heavy duty grease lubricated ball bearings with minimum L10 50,000 hour life. Grease shall be rated for 700 F minimum and resistant to water/condensation. Permanently lubricated bearing may be substituted on small pumps with motors 1.5 HP and lower.

K. Pumps shall have statically and dynamically balance impeller locked via key to the shaft.

L. Factory align and test all pumps per ANSI / Hydraulic Institute recommendations and procedures.

M. Factory paint pumps and pump assemblies with high grade machinery enamel.

2.3 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS (TYPE SC-H-IL)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Fluid Technology.
2. Aurora Pump; Pentair Ltd.
3. Grundfos Pumps Corporation.
4. ITT Corporation.
5. PACO Pumps; Grundfos Pumps Corporation, USA.
6. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
3. Pump Shaft: Solid steel.
4. Seal: Mechanical.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
6. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Motor: Rigidly mounted to pump casing.
1. 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.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS (TYPE SC-BM-ES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Fluid Technology.
   2. Aurora Pump; Pentair Ltd.
   3. Grundfos Pumps Corporation.
   4. ITT Corporation.
   5. PACO Pumps; Grundfos Pumps Corporation, USA.
   6. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings**,** threaded gage tappings at inlet and outlet, and drain plug at bottom and air vent at top of volute. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
   3. Pump Shaft: Solid steel
   4. Seal: Mechanical.
   5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
   6. Pumps shall be equipped with bearing and shaft protection to divert harmful shaft voltages to ground. Bearing protection shall be AEGIS Pro Series, or as approved.
   7. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Secured to mounting frame, with adjustable alignment.
   1. 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.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:
1. Angle pattern.
2. Castorductile-**i**ron body and end cap, pump-inlet fitting. Pressure rating to match corresponding pump.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

2.6 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.
1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet™ IP.
3. Commissioning and pump set up access to pump controls via the following:
   a. A web interface (data exchange).
   b. A user interface located on the face of speed controller to adjust modes and mode values.
   c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.
4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:
   a. Manual (via user interface or HTML).
   b. Remote via 0 to 10 V dc.
   c. Data protocol communications with the BMS.
5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.
7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
8. Pump capable of being monitored continuously via integrated Internet link.
9. Integrated pump controller system to have the following features:
   a. Controller software shall be capable of sensorless control in variable-volume systems without need for pump-mounted (internal/external) or remotely mounted differential pressure sensor.

b. Integrated Pump Controller Sensorless Control: Operates under Quadratic Pressure Control (QPC) to ensure that head reduction with reducing flow conforms to quadratic control curve.
c. Controller:
   1) Minimum head of 40 percent of design duty head.
   2) User-adjustable control mode settings and minimum/maximum head set points using built-in programming interface.
d. Controller Integrated Control Software:
   1) Capable of controlling pump performance for non-overloading power at every point of operation.
   2) Capable of maintaining flow rate data.

2.7 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Provide pumps so they are specified or scheduled with ECM.
   1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
   2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
   3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
   4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
   5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
   6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Inertia Base Equipment Mounting: Install base-mounted pumps with inertia bases on cast-in-place concrete equipment base(s) using restrained spring isolators. Comply with requirements for equipment bases specified in Division 3. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for Piping and Equipment."
   1. Provide vibration control as indicated on Drawings.
   2. Coordinate sizes and locations of concrete bases with actual equipment provided.

E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.
   1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 2322113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check, shutoff, and throttling valves on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.
   7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 233416 - CENTRIFUGAL HVAC FANS

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: For each product.
   1. Backward-inclined centrifugal fans.
   2. Direct Drive Plenum fan array.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Include rated capacities, furnished specialties, and accessories for each fan.
   2. Certified fan performance curves with system operating conditions indicated.
   3. Certified fan sound-power ratings.
   4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   5. Material thickness and finishes, including color charts.
   6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment 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.
   4. Design Calculations: Calculate requirements for selecting vibration isolators, seismic restraints, and for designing vibration isolation bases.
   5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Delegated Design Submittal: For vibration isolation, supports, and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for selecting vibration isolators, supports, seismic restraints, and for designing vibration isolation bases.

D. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for fans, 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.

B. Startup service reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

B. **Motors: One spare motor for each size and type.** **(Add. A)**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:
1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

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. Component Importance Factor: 1.5.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Aerovent; a Twin City Fan company.
   3. Chicago Blower Corporation.
   4. Greenheck Fan Corporation.
   5. Loren Cook Company.
   6. New York Blower Company (The).
   7. Twin City Fan.

B. Description:
   1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
   2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
   3. Factory-installed and -wired disconnect switch.

C. Housings:
   1. Formed panels to make curved-scroll housings with shaped cutoff.
   2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   3. Horizontally split, bolted-flange housing.
   4. Spun inlet cone with flange.
   5. Outlet flange.

D. Backward-Inclined Wheels:
   1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
   2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:
   1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
   2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.

G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Grease Collector and Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 DIRECT DRIVE PLENUM FAN ARRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme
2. Aerovent; a Twin City Fan company.
3. Daikin
4. PennBarry
5. Greenheck Fan Corporation.
6. Loren Cook Company.
7. Twin City Fan.

B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

3. Where multiple fans are connected to a single VFD, provide power distribution panel (PDP) in a NEMA 1 enclosure and factory mounted. Each fan in the fan array shall be factory wired to the PDP. Single source power motor control panel with short circuit protection, manual motor overload, alarm relay, manual motor protector shall be provided for each fan in the fan array. Factory wiring from PDP panel to motors in shall be liquid-tite conduit per local codes. Manual motor protectors shall meet the following requirements:
   a. Description: UL 508 Type E self-protected combination manual motor controller installed in an enclosure with a pad-lockable, door-mounted handle mechanism. Door-mounted handle shall have clearly labeled ON, OFF, and TRIP positions. Disconnect switch shall be suitable for motor loads.
   b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Schneider Electric, Inc.
      2) Eaton Corporation
      3) Siemens Energy & Automation, Inc.
      4) ABB; Control Products.
      5) Rockwell Automation, Inc.: Allen-Bradley brand
      6) General Electric Company; GE Consumer & Industrial
   c. Tripping Elements:
      1) Adjustable, inverse time-delay thermal overcurrent release for Class 10 overload protection.
      2) Fixed, instantaneous release for short-circuit protection.
   d. Short Circuit Rating: 50kA minimum @ 480V. Short circuit rating must be provided by the manual motor protector assembly, and shall not rely on upstream overcurrent protective devices to provide a minimum short circuit rating.
   e. Operating Temperature: -4 degrees F to 140 degrees F with ambient temperature compensation
   f. Accessories:
      1) Line side insulating barrier as required for UL 508 Type E listing.
      2) Short-circuit trip indication as required for UL 508 Type E listing, to differentiate between thermal and short-circuit trips.
      3) (1) NO auxiliary contact, open when the disconnect switch is in the OFF or TRIP position.

C. Airfoil Wheels:
   1. Single-width-single-inlet construction with smooth-curved inlet flange.
   2. Heavy backplate.
   3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
   4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

D. Shafts:
   1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

F. Accessories:
1. Provide fans with extended lubrication kits with flexible tubing, fittings and hardware for field installation.
2. Provide blank off mounting points for each fan in a fan array assembly, with a minimum of one blank off plate and hardware per array.
3. Provide each fan in the fan array with shaft grounding rings.
4. Provide each fan in the fan array with piezometric ring for air flow measurement by the building automation system. Insertion type probes at the fan scroll inlet are not acceptable.

2.4 VEHICLE EXHAUST EXTRACTION SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Monoxivent
2. Nederman
3. Plymovent

B. Overhead Exhaust Extraction System
1. Centrifugal Fan.
2. Retractable balancer/torque reel.
3. Swinging swivel boom arm with mounting bracket.
4. Flexible double ply hose with inner ply of woven fiberglass coated silicone rubber, a helically wound spring steel wire imbedded between the inner ply and exterior ply, and an exterior ply of woven nomex coated with silicone rubber. 8" diameter and 24ft length. 600 degree F continuous duty.
5. Tailpipe adapter nozzle with safety breakaway feature.

2.5 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."

2.6 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting: Install centrifugal fans on vibration isolation equipment base. Comply with requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" and as indicated in Drawings.

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:
1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

8. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
9. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 233423 - HVAC POWER VENTILATORS

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. Centrifugal roof ventilators.
   2. In-line centrifugal fans.
   3. Centrifugal high plume laboratory exhaust fans.
   4. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Roof curbs.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For vibration isolation, supports, and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for selecting vibration isolators, supports, seismic restraints, and for designing vibration isolation bases.

D. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for fans, 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.

B. Startup service reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators 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. Belts: One set for each belt-driven unit.
   2. **Motors: One spare motor for each size and type.** **(Add. A)**

1.8 QUALITY ASSURANCE

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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

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. Component Importance Factor: 1.5.

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Acme Engineering & Manufacturing Corporation.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. Greenheck Fan Corporation.
4. JencoFan.
5. Loren Cook Company.
6. PennBarry.
7. Twin City Fan

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor isolated from exhaust airstream.

E. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Pitch Mounting: Manufacture curb for roof slope.

2.3 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Acme Engineering & Manufacturing Corporation.
2. Carnes Company.
3. Greenheck Fan Corporation.
4. Hartzell Fan Incorporated.
5. JencoFan.
6. Loren Cook Company.
7. Madison Manufacturing.
8. PennBarry.
9. Quietaire Inc.
10. Twin City Fan

B. Housing:
1. Split, spun aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, sidewall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels:
1. Alunimum, airfoil blades welded to aluminum hub.

F. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.

2.4 CENTRIFUGAL HIGH PLUME LABORATORY EXHAUST FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Acme Engineering & Manufacturing Corporation.
2. Carnes Company.
3. Greenheck Fan Corporation.
4. Hartzell Fan Incorporated.

5. JencoFan.
6. Loren Cook Company.
7. Madison Manufacturing.
8. PennBarry.
9. Quietaire Inc.
10. Twin City Fan

B. Corrosion Resistant Coating:
1. All fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with a two part electrostatically applied and baked, sustainable, corrosion resistant coating system. Standard finish color.
2. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
3. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.
4. The coating system, a total thickness of up to 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray.
5. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.

C. Housing:
1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan housing shall be welded steel and meet specification section for corrosion resistant coating. No uncoated metal fan parts shall be acceptable.
3. A high velocity conical discharge nozzle or induction discharge nozzle (as scheduled) shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
4. Provide housing drain for removal of rain and condensation.
5. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
6. Manufacturer’s standard finish color.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels:
1. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.

2. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and meet specification section for corrosion resistant coating.

F. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.
2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.

2.5 PROPELLER FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Acme Engineering & Manufacturing Corporation.
2. Carnes Company.
3. Greenheck Fan Corporation.
4. Hartzell Fan Incorporated.
5. JencoFan.
6. Loren Cook Company.
7. Madison Manufacturing.
8. PennBarry.
9. Quietaire Inc.
10. Twin City Fan

B. Housing: Galvanized steel sheet with flanged edges and integral orifice ring with baked enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed steel blades riveted to a heavy gauge steel spider bolted to a cast iron hub.

D. Fan Wheel: Replaceable, cast aluminum, airfoil blades fastened to a cast aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 5 horsepower; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories: As scheduled on the Drawings; options include the following:
1. Motor Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Weathershield Hood: Galvanized steel to match fan and accessory size.
4. Weathershield Front Guard: Galvanized steel with expanded metal screen.
5. Variable Speed Controller: Solid state control to reduce speed from 100 percent to less than 50 percent.
6. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: See Schedule on the Drawings.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   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. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Verify lubrication for bearings and other moving parts.
   7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   8. Shut unit down and reconnect automatic temperature-control operators.
   9. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust belt tension.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION

SECTION 233433 - AIR CURTAINS

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 air curtains hot-water heat.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties, and accessories.

B. Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
   1. Provide delegated-design submittal for air curtain units indicated to comply with performance requirements and design criteria.
      a. Detail fabrication and assembly of air-curtain unit mounting assemblies.
      b. Include design calculations for selecting vibration isolators and seismic restraints.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtains to include in maintenance manuals.

1.5 QUALITY ASSURANCE

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 AMCA 220, "Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings," for airflow, outlet velocity, and power consumption.

C. Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
   1. Certify coils according to ARI 410.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air curtains that fail in materials or workmanship within specified warranty period.
   1. Warranty Period (Water or Steam Heating Units): 24 months.

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. Filters: One set(s) for each air-curtian unit. (Add. A)

PART 2 - PRODUCTS

2.1 AIR-CURTAIN UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berner International.
   2. Mars Air Products; Dynaforce Division.
   3. Powered Aire, Inc.
   4. TMI, LLC; Curtron Products Division.

B. Housing:
   1. Materials: Heavy-gage, aluminum construction with polyester white painted finish.
   2. Discharge Nozzle: Integral part of the housing, containing adjustable air-directional vanes with 20 -degree sweep front to back.

C. Mounting Brackets: Steel, for recessed ceiling mounting or wall mounting as indicated on the drawings.

D. Air-Intake Grille:
   1. Grille: Integral part of and same material as the housing.

E. Fans:
   1. Centrifugal, forward curved, double width, double inlet.
   2. Galvanized steel.
   3. Statically and dynamically balanced.

F. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Multispeed.
   3. Resiliently mounted.
   4. Continuous duty.
   5. Integral thermal-overload protection.
   6. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
   7. Disconnect: Internal power cord with plug and receptacle.

G. Water Coils:
   1. Piping Connections: Threaded on same end.
   2. Tube Material: Copper, complying with ASTM B 75.
      a. Tube Diameter: 0.625 inch.
   3. Fins: Aluminum.
   4. Ratings: According to ASHRAE 33.
   5. Working-Pressure Ratings: 200 psig, 325 deg F.

H. Filters:
   1. Washable Panel Filters: Recleanable, polyester filters.

I. Controls:

1. Built-in Return Air Thermostat: Factory installed and wired to the motor-control panel.
2. Automatic Door Switch: Roller type Combination roller-plunger type Plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hot-water piping systems to verify actual locations of piping connections before air-curtain installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install air curtains with clearance for equipment service and maintenance.

B. Equipment Installation: Install air curtains with seismic-restraint devices. Comply with requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Comply with requirements for heating hot water piping specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   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. Tests and Inspections:
   1. After installing air curtains completely, perform visual and mechanical check of individual components.
   2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
   3. Inspect for water leaks.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-curtain unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust belt tension.

B. Adjust motor and fan speed to achieve specified airflow.

C. Adjust discharge louver and dampers to regulate airflow.

D. Adjust air-directional vanes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air curtains.

END OF SECTION

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. LEED Submittals:
   1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. For Compressor: Five year(s) from date of Substantial Completion.

1.8 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. Filters: One set(s) for each air-conditioner unit. (Add. A)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product (Units 5 Tons or Less): Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Bosch
   2. Daikin.
   3. LG.
   4. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
   5. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
   4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
   5. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
   6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   7. Filters: Permanent, cleanable.

8. Condensate Drain Pans:
   a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 2 inches deep.
   b. Single-wall, stainless-steel sheet.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      1) Minimum Connection Size: NPS 1.
   d. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
   e. Condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll or reciprocating.
      b. Refrigerant Charge: R-454B or R-32.
      c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub cooler Comply with ARI 210/240.
   3. Fan: Aluminum-propeller type, directly connected to motor.
   4. Motor: Permanently lubricated, with integral thermal-overload protection.
   5. Low Ambient Kit: Permits cooling operation down to 0 deg F.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

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 hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install seismic restraints.

D. Install compressor-condenser components on elevated mounting base with vibration isolation as indicated on the Drawings. . See Section 230548 "Vibration and Seismic Controls for Piping and Equipment."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

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.

B. Perform tests and inspections.
   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.

C. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238219 - FAN COIL UNITS

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 fan-coil units, blower-coil units, and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:
   1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

   2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fan coil units, 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.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.7 QUALITY ASSURANCE

A. 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.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate layout and installation of fan-coil units, blower-coil units, and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.9 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. Filters: One set(s) for each fan-coil unit. (Add. A)

PART 2 - PRODUCTS

2.1 FAN-COIL UNITS

A. Basis-of-Design Product: Provide product indicated on the drawings or a comparable product by one of the following:
1. Carrier Corporation.
2. International Environmental Corporation.
3. Daikin Applied (formerly McQuay International).
4. Johnson Controls
5. Price
6. Rittling.
7. Titus
8. Trane.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1/2-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Main and Auxiliary Drain Pans: Insulated stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.
1. Provide condensate overflow switch and condensate pump.

E. Chassis: Galvanized steel where exposed to moisture.

F. Cabinet: Galvanized steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 8 MERV.
   2. Pleated Cotton-Polyester Media: 13 MERV for BCU

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Electric-Resistance Heating Coils: SCR modulation. Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

J. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, ECM; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.

K. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC."

L. BAS Interface Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.
   3. Provide BACnet interface for central BAS workstation for the following functions:
      a. Adjust set points.
      b. Fan-coil-unit start, stop, and operating status.
      c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature.
      d. Occupied and unoccupied schedules.
      e. Condensate overflow alarm.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil and blower-coil units level and plumb.

B. Install fan-coil and blower-coil units to comply with NFPA 90A.

C. Mount fan-coil and blower coil units as indicated on the drawings. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil and blower-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to fan-coil- and blower-coil- unit factory hydronic piping package. Install piping package if shipped loose.
   3. Connect condensate drain to indirect waste.
      a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to ducted fan-coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 238239 - UNIT HEATERS

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. Cabinet unit heaters with centrifugal fans and hot-water coils.
   2. Propeller unit heaters with hot-water coils.
   3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Sustainable Design Submittals:

   1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Location and arrangement of integral controls.
   2. Wiring Diagrams: Power, signal, and control wiring.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
   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. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. 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.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 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. Filters: One set(s) for each unit heater. (Add. A)

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Carrier Corporation.
2. Dunham-Bush, Inc.
3. International Environmental Corporation.
4. McQuay International.
5. Modine
6. Rittling
7. Sterling
8. Trane.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.
1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Recessing Flanges: Steel, finished to match cabinet.
3. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
4. Extended Piping Compartment: 8-inch- wide piping end pocket.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and 7 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC".

I. Electrical Connection: Factory wire motors and controls for a single field connection.

2.2 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Airtherm; a Mestek Company.
2. Engineered Air Ltd.
3. King Electrical MFG Co.
4. McQuay International.
5. Modine
6. Rittling.
7. Sterling.
8. Trane.

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

K. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

L. Control Devices:
1. Wall-mounting thermostat.

2.3 ELECTRIC WALL AND CEILING HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Berko Electric Heating: a division of Marley Engineered Products.
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. King Electrical MFG Co.
5. Markel Products; a division of TPI Corporation.
6. Marley Electric Heating: a division of Marley Engineered Products.
7. Ouellet Canada Inc.
8. QMark Electric Heating; a division of Marley Engineered Products.
9. Trane.

C. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

D. Cabinet:
1. Front Panel: Heavy-gauge steel, slotted, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

E. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

G. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

H. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

I. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install wall-mounting switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping."

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 238413 - HUMIDIFIERS

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 humidifiers:
   1. Self-contained.

1.3 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.7 MAINTENANCE MATERIAL SUBMITTALS (Add. A)

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. (Add. A)

1. Supply one replacement electrode cylinder with each self-contained humidifier. (Add. A)

2. Cartridge-Filter Elements: Elements for cartridge filters equal to 200 percent of amount installed for each size and media indicated. (Add. A)

PART 2 - PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong International, Inc.
   2. DRI-STEEM Humidifier Company.
   3. Neptronic.
   4. Condair Inc.
   5. Pure Humidifier Company

B. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 316 stainless steel. Comply with UL 499.

C. Electrode Cylinder: Replaceable plastic assembly. Comply with UL 499.

D. Manifold: ASTM A 666, Type 304 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

E. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

F. Control Panel:
   1. Factory-wired disconnect switch.
   2. Liquid-crystal display.
   3. Programmable keyboard.
   4. Set-point adjustment.
   5. Low-voltage, control circuit.
   6. Diagnostic, maintenance, alarm, and status features.
   7. High-water float to prevent overfilling.

G. Controls:
   1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
   2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
   3. Field-adjustable timer to control drain cycle for flush duration and interval.
   4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
   5. **Float**-type level controls.

H. Accessories:
   1. Duct-mounting, high-limit humidistat.
   2. Airflow switch for preventing humidifier operation without airflow.
   3. Condensate cooler.

2.2 PACKAGED REVERSE OSMOSIS SYSTEM

A. Humidifier manufacturer to provide RO system for resistance type humidifiers with the following components.
   1. Prefilter

2. Reverse-osmosis unit (RO) water treatment system
3. System controls
4. Pressurized storage

B. RO water treatment system shall include:
1. Frame shall be steel, primed and finished with powder-coat epoxy paint. Frame shall be equipped for and support loads imposed during rigging and operation. Frame shall house RO pump and system control components described below.
2. RO system shall be rated for flow at 50°F inlet water temperature.
3. RO water treatment system components shall be prewired and sized to full load capacity. Components, features, and functions shall include:
a. Brass rotary pump and premium efficient ODP motor with drip cover.
b. RO membrane(s): Extra low energy thin-film composite (TFC), high-efficiency, high-flow filtering membrane(s).
c. RO Pressure Vessel(s): Stainless steel with clamp style.
d. Automatic inlet feed solenoid valve, brass construction.
e. Permeate flow meter, panel mounted.
f. Concentrate flow meter, panel mounted.
g. Recycle flow meter, panel mounted.
h. Concentrate to drain control valve.
i. Recycle control valve.
j. Permeate check valve.
k. Low pressure pump protection.
l. Pressure transmitter for filter inlet, filter outlet, tank pressure; 316L SS material.
m. Liquid filled pressure gauges for filter in/out and system pressures, panel mounted, SS construction.
n. TDS sensor with LED display.
o. System on-off with pressure kit and dual shut-off valves.
p. Permeate manifold for connections to pressurized tank and process equipment.
q. Water inlet low-pressure detection.
r. Automatic membrane fast flush on startup capability.
s. Automatic membrane flush based on inactivity capability.
t. 5-micron sediment filter.
u. 10-micron carbon cartridge (quantity 2).
v. Pressurized RO holding tank mounted on RO frame.
1) Carbon steel pressurized storage tank: Manufacturer shall provide minimum 4.4 gallon painted carbon steel storage tank with rubber bladder. The tank shall have one water connection and an air Schrader valve to fill the bladder side with compressed air.
w. Microprocessor controller with LED keypad display and the following functions:
1) Interoperable with any BACnet® network using IP connection.
2) USB port on the control board for software updates, data backups, and data restoration.

3) Up-time optimizer function to keep ROs operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time.
4) Real-time clock to allow time-stamped alarm/message tracking, and scheduled events.
5) Factory commissioning of control board, including system configuration as-ordered.
6) Keypad/display operable within a temperature range of 32 to 158 °F (0 to 70 °C), and that provides backlighting for viewing in low light.
7) Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.
8) The capability to monitor, control, and/or adjust the following parameters:
    a) System alarms and system messages, current and previous.
    b) Adjustable water flush duration and frequency.
    c) Programmable outputs for remote signaling of alarms and/or messages.
    d) System diagnostics that include: Test outputs function to verify component operation; Test RO function, by simulating demand to validate performance; Data collection of TDS, inlet pressure, post filter pressure, storage tank pressure, water pump hours, alarms, and service messages for viewing from the keypad/display or BACnet integration.
    e) Password-protected system parameters.
    f) Numerical units displayed in inch-pound or SI units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers and RO systems with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install stainless-steel duct section with drain at each manifold mounted in duct.
    1. Connect to condensate trap and drainage piping.

2. Extend sloped duct upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1. Refer to detail on drawings.

E. Install manifold supply piping pitched to drain condensate back to humidifier.

F. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
1. Install piping adjacent to humidifiers to allow service and maintenance.

2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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. Report results in writing.

B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers and RO systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITALLS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Vacancy sensors.
   2. Interconnection diagrams showing field-installed wiring, all devices and equipment shown on reflected ceiling plans, drawn to scale.
   3. Include diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. As-built drawings for the lighting control system.

C. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.

   2. Warranty Period: Two year(s) from date of Substantial Completion.

1.5 MAINTENANCE MATERIAL SUBMITTALS (Add. A)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Automatic sensor type and manual control type, line and low voltage lighting control devices: 15 of each type and rating used. (Add. A)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products compatible with system specified in Section 260943 "Network Lighting Controls".

2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Description: System operates indoor lighting.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   1. Lighting control set point is based on the following two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.5 EMERGENCY LIGHTING CONTROL RELAY

A. Description: Emergency lighting control relay which bypasses all local dimming/switching controls upon loss of normal power.
   1. Voltage: 120V or 277V as required to match circuit voltage.
   2. Dimming: Capable of acception 0-10V dimming signal and passing through the signal during normal operation. Relay shall bring the connected light fixtures to full brightness upon loss of normal power.
   3. Current rating: 16A, minimum.
   4. Compatible Load Types: LED.
   5. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
   6. Test Switch: Visible momentary contact switch.
   7. UL 924 Listed.

2.6 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bodine.
   2. Hubbell.
   3. ETC.

B. Description: Emergency lighting transfer device which automatically transfers to an emergency power source upon loss of power and overrides all local dimming/switching controls.
   1. Voltage: 120V or 277V.
   2. Current Rating: 16A, minimum.
   3. Compatible Load Types: Incandescent, halogen, magnetic ballasts, electronic ballasts, LED drivers.
   4. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
   5. Test Switch: Visible momentary contact switch.
   6. UL 1008 Listed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
   3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in other sections.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 262300 - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:
   1. Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19 "Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
   2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   3. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for switchgear.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For low-voltage switchgear.
   1. System Power One-Line Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
      a. Frame size of each circuit breaker.
      b. Trip rating for each circuit breaker.
      c. Conduit and wire size for each feeder.
   2. Include plans, elevations, sections, shipping splits, and mounting details.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
   5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
   6. Indicate short-time and short-circuit current rating of switchgear assembly.

7. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include mimic-bus diagram.

C. Delegated-Design Submittal: For low-voltage switchgear.
1. For the differential ground-fault protection scheme. Include wiring diagram of the differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around the low-voltage switchgear where pipe and ducts are prohibited.

B. Qualification Data: For testing.

C. Seismic Qualification Data: Certificates, for switchgear, 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 Test Reports: Submit evidence that switchgear is compatible with connected monitoring and control devices and systems specified in Section 260913 "Electrical Power Monitoring and Control."
1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

E. Protective Relay Database Files
1. Create relay database files formatted as required by protective relay manufacturer.
a. Files shall include settings recommended by Section 260573 Power System Studies.
b. Files shall include I/O need for system operation per schematics and wiring diagrams.
c. This requirement includes all logic required in the relay for functional performance.

F. Source quality-control reports.

G. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device.
      b. Lists of spare parts and replacement components recommended for storage at Project site.
      c. Detailed instructions covering operation under both normal and abnormal conditions.
      d. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.5 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. Fuses: One for every three of each type and rating, but no fewer than three of each for the following:
      a. Potential transformers.
      b. Control power circuits.
   2. Drawout Circuit Breakers: One of each type and rating used for circuit breaker in the switchgear.

B. System Power Riser Diagram: For each switchgear, post on the wall at each location, using non-fugitive ink on high-quality paper.

C. Maintenance Tools: Furnish tools and miscellaneous items required for low-voltage switchgear test, inspection, maintenance, and operation. Include the following: (Add. A)
   1. Floor-running transport or dockable dolly with manual lifting mechanism and all other items necessary to remove circuit breaker from housing and transport it to remote location.
   2. Racking handle to move circuit breaker manually between connected and disconnected positions. (Add. A)

1.6 QUALITY ASSURANCE

A. Testing Qualifications: Accredited by NETA.
   1. Testing Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Indoor Switchgear Storage: Store in a dry, clean location, placed on a level surface to prevent strain and possible distortion. During the construction period, provide protection against dust, dirt, falling objects, dripping water, water, excessive moisture, and other possible causes of damage to the equipment. Any temporary covering shall not restrict ventilation and may not be removed until the equipment is ready for installation. Take special precaution to keep the equipment sufficiently warm with adequate ventilation to prevent condensation during the storage period. Install temporary heating if necessary.

B. When provisions for temporary power connection are provided as part of the switchgear assembly, provisions shall be included to prevent energization of primary buses or connections by means of backfeed through fuses or control power transformers connected to the primary buses or connections.

C. If outdoor switchgear cannot be installed and energized, temporary power shall be provided for the operation of the space heaters provided so as to prevent condensation of moisture within the housing.

D. Ventilation openings shall be left open to permit proper air circulation.

1.8 FIELD CONDITIONS

A. Ambient Environment Ratings:
1. Ambient Temperature Rating: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Humidity Rating: Less than 95 percent (noncondensing).
3. Altitude Rating: Not exceeding 6600 feet.
4. The effect of solar radiation is insignificant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB Inc.
2. Eaton.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

2.2 SYSTEM DESCRIPTION

A. Description: Metal-enclosed, low-voltage switchgear with drawout power circuit breakers, with accessories and metering components.
1. 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.
2. Comply with IEEE C37.20.1.
3. Listed and labeled as complying with UL 1558.

4. Listed and labeled for use as service entrance equipment.

B. Service Entrance Switchgear (SES) "main" and "PV" circuit breakears shall be controlled by remote multiple-generator and PV paralleling microgrid monitoring and control system.
   1. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

C. Switchgear circuit breakers trip units report metering and monitoring data to multiple-generator and PV paralleling microgrid monitoring and control system.
   1. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

D. Service Entrance Switchgear (SES) "main" circuit breaker protective relays shall be equipped to control main circuit breakers and tie-into remote multiple-generator and PV paralleling microgrid monitoring and control system to satisfy utility requirements

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchgear shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the assembly will remain in place without separation of any parts when subjected to the seismic forces specified and the assembly will be fully operational after the seismic event."
   2. Component Importance Factor: As shown in Structural drawings.
   3. Component Amplification Factor and Component Response Modification Factor: As shown in Structural drawings.

B. Capacities and Characteristics: As shown on Drawings
   1. Short-Time and Short-Circuit Current: Match rating of integrated short-circuit current rating.

2.4 SWITCHGEAR STRUCTURE

A. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker. Extend section barriers between main and tie circuit breakers to the rear of the section.

B. Allow the following circuit-breaker functions to be performed when the compartment door is closed:
   1. Operate manual charging system.
   2. Open and close the circuit breaker.
   3. Examine and adjust the trip unit.
   4. Read the breaker nameplate.

C. Install instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires, and cables.

D. Switchgear Bus:
1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
2. Main Phase Bus: Uniform capacity the entire length of assembly.
3. Neutral Bus: 100 percent of phase-bus ampacity unless otherwise indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4. Ground Bus: Uniform capacity the entire length of assembly, with pressure connector terminations for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
5. Vertical Section Bus Size: Fully rated to the system continuous current, equal to the horizontal bus.
6. Bus Material and Connections:
   a. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   b. Use copper for connecting circuit-breaker line to copper bus.
   c. Contact Surfaces of Buses: Silver plated.
   d. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with compression connectors for outgoing circuit conductors.
7. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
8. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
   a. Sprayed Insulation Thickness: 3 mils, minimum.
   b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

E. Circuit-Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
   a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
   b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   c. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from connected, test, and disconnected positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from the structure. When compartment door is open, status for connection devices for different positions includes the following:

1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

d. Primary Disconnect: Mount on the stationary part of the compartment. Disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the connected position. Assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall connect to bus extensions that terminate in solderless terminals in the rear cable compartment.

e. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of breaker.

f. Provide a verification of positive ground contact between the circuit breaker and its compartment when the accessory cover is removed while the circuit breaker is in connected, test, disconnected, and withdrawn positions.

g. Place 2400-A frame and larger circuit breakers at the bottom of switchgear.

F. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
1. Utility metering compartment that complies with utility-company requirements.
2. Service Entrance Switchgear (SES) "main" circuit breaker protective relaying compartment.
3. Bus transition sections.
4. Incoming-line pull sections.
5. Hinged front panels for access to metering, accessory, and blank compartments.

G. Pull Boxes: Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and with ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
1. Set pull box back from front to clear circuit-breaker lifting mechanism.
2. Pull-Box Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
3. Cable Supports: Arranged to ease cabling and adequate to support cables, including those for future installation.

2.5 ADDITIONAL REQUIREMENTS FOR INDOOR SWITCHGEAR

A. Enclosure Rating: Indoor.

B. Enclosure Material: Steel.

C. Enclosure Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Enclosure Rear Panels: Removable and hinged, to allow access to rear interior of switchgear.

2.6 CIRCUIT BREAKERS

A. Drawout type, unfused, power operated, with electromechanical or electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.

B. Ratings: For continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear. Comply with IEEE C37.16.
   1. Circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 A, whether or not equipped with instantaneous trip protection.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   3. Stored-Energy Mechanism: Electrically charged, and the operator's choice of manual charging.
      a. Operating Handle: One for each circuit breaker capable of manual operation.
      b. Electric Close Button: One for each electrically operated circuit breaker.
   4. Provide an interlock to discharge the stored energy mechanism before the circuit breaker can be withdrawn from its compartment.
   5. Operation counter.

D. Operator Display: Located on the face of the circuit breaker.
   1. Electrical operation buttons to open and close the circuit breaker. Provide a clear lockable cover over the buttons.
   2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. An energized or hot condition shall be indicated by a red light. The de-energized, open, and safe condition shall be indicated by a green light.
   3. Indicator to show the position of the circuit-breaker contacts, status of the closing springs, and circuit-breaker position in its compartment.
   4. Provide a "charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.
   5. Remote Computer Display: One or more computer displays, each with a dedicated CPU, to display data that are generated for transmission via the Ethernet connection. Display the following functions:
      a. Circuit-breaker status and circuit-breaker controls status.
      b. Onboard meters.
      c. User settings for overcurrent protection and undervoltage protection.
      d. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
      e. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

E. Overcurrent Protective Tripping: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
   1. Programmable functions independent of each other in both action and adjustment.
      a. Long-time setting.
      b. Long-time-delay with selectable I2T or I4T curve shaping.
      c. Short-time setting.
      d. Short-time-delay with flat or selectable I2T curve shaping.
      e. Instantaneous trip.
   2. Field-adjustable, time-current characteristics.
   3. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
   4. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   5. Pickup Points:
      a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-T operation.
      b. Five minimum, for instantaneous-trip functions.

F. Ground-Fault Protection:
   1. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.
   2. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
   3. Test Form: Provide each ground-fault relay with information sheets describing system-testing instructions, and with a test form; comply with UL 1558.

G. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

H. Shunt-Trip Devices.

I. Metering:
   1. Accuracy: 0.5 percent of reading, complying with ANSI C12.20.
   2. Values shall be rms average over a period of one second.
      a. Current: Each phase, neutral and three-phase average.
      b. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
      c. Active Power (kW): Each phase and three-phase total.
      d. Reactive Power (kVAr): Each phase and three-phase total.
      e. Apparent Power (kVA): Each phase and three-phase total.
      f. Power Factor: Each phase and three-phase total.
      g. Active Energy (kWh): Three-phase total.

J. Auxiliary Contacts:
   1. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.

2. Spare auxiliary switches, at least two, unless otherwise indicated. Each switch shall consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.
3. Service Entrance Switchgear (SES) "main" and "PV" circuit breakers shall be equipped for remote control by the multiple-generator and PV paralleling microgrid monitoring and control system.
    a. Closed
    b. Open
    c. Tripped
    d. Cradle Position (connected/disconnected/test)
    e. Remote Close (signal & return)
    f. Remote Trip (signal & return)
    g. Ground Fault Alarm
    h. Normal After Trip (NAT)

K. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

L. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

M. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

N. Key Interlocks: Arranged to prevent opening or closing of interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.

2.7 ARC-FLASH LIMITING FEEDER CIRCUIT BREAKERS

A. Feeder circuit breakers shall be without current-limiting fuses, listed as complying with UL 1066.

B. Short-circuit withstand current rating shall be 200 kA.

C. Equip the arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as a temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.
1. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
2. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
3. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
4. Provide dry relay contacts on each switch for annunciation of the switch position.

2.8 PROTECTIVE RELAYS

A. Provide a protective relay for Service Entrance Switchgear (SES) "main" circuit breaker as indicated on Drawings and with recommended settings and programming by the power systems study. Protective relays shall meet the minimum requirements for the circuit breaker application (main, feeder, busbar, capacitor, transformer, generator, etc.) with the protection types (ANSI/IEEE C37.2 device numbers) and protection levels (basic, standard, advanced) specified or shown.

B. Manufacturers: Subject to compliance with requirements, provide Multifunctional, solid-state microprocessor-based relay systems, complying with IEEE C37.90 products by Schweitzer Engineering Laboratories (SEL) Co.

C. (SEL) Relay Packages as indicated on Drawings and required by Utility.

D. Visual Display:
   1. 5-inch, 800 x 480 color touchscreen display.
   2. 4 customizable pushbutton and labels.
   3. Each pushbutton shall be equipped with two programmable LED's.

E. Relay Mounting: Each relay shall be equipped at the service entrance integral to the service entrance switchgear assembly to satisfy the utility backfeed restriction requirements.

F. Equip each relay system with a communication module to transfer data between relay and multiple-generator and PV paralleling microgrid monitoring and control system:
   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.
   3. The relay shall be equipped for the functions indicated in the drawings and all metering and monitoring. Minimum capabilities for each relay:
      a. Ethernet: Dual 10/100-Base-T1.
      b. Ethernet/IP Protocol.
      c. Two EIA-232
      d. Slot C with three additional digital inputs.
      e. Slot C with four additional digital outputs.
      f. Slot C with one additional analog output (4-20mA).

G. Instrument Transformers: Comply with IEEE C57.13.
   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 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.

2.9 SURGE SUPPRESSION

A. Surge Suppression: Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:
   1. Integral disconnect switch.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5-A 250-V ac, one NO and one NC, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter.

2.10 CONTROL POWER SUPPLY, 120-V AC

A. Control Power Transformer: Supply 120-V control circuits through dry-type control power transformers, include secondary disconnect devices.
1. Place transformers larger than 3 kVA in separate compartments at the bottom of the vertical section, including the related primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker and PV circuit breaker.
   a. Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
   b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

2.11 CONTROL POWER SUPPLY, 24-V DC

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity shall be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.

B. Battery: Premium VRLA batteries, with battery disconnect and overcurrent protective device.

C. 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.

D. Accessories:
1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall 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.
1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
3. 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.
4. 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.
5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation shall be automatic until manually reset.
6. 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 shall resume after loss of ac power supply for any interval.
7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device shall regulate charging current but shall not disconnect charger from either battery or ac supply.
8. Charger's Audible Noise: Less than 26 dB.

2.12 INSTRUMENTATION AND CONTROL

A. Power Distribution Equipment shall be web enabled, direct connected to the Local Area Network (LAN) or Intranet.

B. Ethernet Connectivity:
1. Install a multipoint, RS-485 Modbus serial communications network within the switchgear to interconnect all breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network shall be wired to an Ethernet gateway in the switchgear. Gateway shall be web enabled, with integral network port and embedded web server with factory-configured firmware and HTML-formatted web pages for viewing of power monitoring and equipment status information from switchgear devices equipped with digital communication ports.
3. LAN shall consist of a multipoint, RS-485 Modbus serial communication network to interconnect all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network shall be connected to Ethernet server that functions as a gateway and server, providing data access via LAN.
4. Server Configuration:
    a. Initial network parameters set using a standard web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.

b. Network server shall be factory programmed with embedded HTML-formatted web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard web browser.
c. Password-protected login, with password administration accessible from the LAN using a standard web browser.
d. Operating Software: Suitable for local access; firewall protected.

5. All serial communications devices within the equipment shall be addressed at the factory and tested.

C. Instrument Transformers: Comply with IEEE C57.13. Instrument transformers may not be used to power space conditioning equipment associated with outdoor switchgear, of for power to convenience receptacles and lighting.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 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.

D. Analog Instruments: Rectangular, 4-1/2 inches square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.
1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
a. Operation: Counts and records a succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. Power Monitoring: Separately mounted, modular, permanently installed, solid-state, digital I/O multifunction metering instrument for power and energy metering and monitoring, complying with UL 61010-1.
1. Capable of metering four-wire Y, three-wire Y, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue-related metering from unauthorized and accidental changes.
3. Comply with IEC 60529 degree of protection code of IP65 for the front of meter, and code of IP30 for the body.
4. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
5. Accuracy:

a. Comply with ANSI C12.20, Class 0.5.
b. Neutral Current Measurement: Not more than 0.65 percent.
c. Power Factor: 1.0 percent.
d. Frequency: 0.1 percent.
e. THD: 1.0 percent.
f. Waveform Sampling: 64 per cycle.

6. Data Link: Ethernet connectivity specified in this article.
7. Meter Physical Characteristics:
   a. Display: Backlit LCD with antiglare and scratch-resistant lens.
   b. Display of Metered Values: One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
      1) All meters.
      2) Measurements.
      3) THD.
      4) Energy.
      5) Demand.
      6) Minimum and maximum values.
      7) Power demand.
8. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.
9. Meters:
   a. Instantaneous, rms:
      1) Current: Each phase, neutral and three-phase average.
      2) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
      3) Active Power (kW): Each phase and three-phase total.
      4) Reactive Power (kVAr): Each phase and three-phase total.
      5) Apparent Power (kVA): Each phase and three-phase total.
      6) Power Factor: Each phase and three-phase total.
   b. Energy:
      1) Active Energy (kWh): Three-phase total.
   c. Demand, Derived from Instantaneous rms Meters:
      1) Current: Present and maximum.
      2) Active: Present and maximum.
      3) Reactive: Present and maximum.
      4) Apparent: Present and maximum/
   d. Power Quality Measurements:
      1) THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
10. I/O: Two optically isolated digital outputs for KYZ pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
    a. KYZ Pulse: Generate standard KYZ pulses for a user-defined increment of metered active energy as follows:
       1) User-defined pulse output, associated with kWh.
       2) User-defined pulse output, associated with kVArh.

11. Capacities and Characteristics:
    a. Circuit Connections:
        1) Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect to instrument-grade potential transformers secondary at 120 V. Meter impedance shall be 2 Mohms L-L or greater.
        2) Overload Tolerance: 1500-V ac, rms, continuously.
        3) Current: Connect to instrument-grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
        4) Frequency: 45 to 65 Hz.
        5) Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.13 POWER TRANSFER CONFIGURATIONS

A. Field-installed and -tested controls of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers to accomplish remotely managed automatic transfer controls for switchgear having two power sources.

B. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

C. Control Wiring:
1. Internal control wiring is factory installed, complete with bundling, lacing, and protection.
2. Remote control wiring is field installed.
3. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
4. Install plugs in control wiring at shipping splits.
5. Remote control wiring for Service Entrance Switchgear (SES) "main" and "PV" circuit breaker control via auxiliary contacts. See 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers.
    a. Closed
    b. Open
    c. Tripped
    d. Cradle Position (connected/disconnected/test)
    e. Remote Close (signal & return)
    f. Remote Trip (signal & return)
    g. Ground Fault Alarm
    h. Normal After Trip (NAT)

D. Two-Breaker Transfer Control: Remotely managed by the multiple-generator and PV paralleling microgrid monitoring and control system. See Section 262313 "Paralleling Low-voltage Switchgear" for remote control circuit breaker management.
1. Two-breaker transfer control shall provide for the local SES switchgear "PV" circuit breaker to be electrically interlocked with a remote a separate switchgear (GMDB) "PV" circuit breaker to restrict the closing the "PV" circuit breaker pair simultaneously. SES "PV" circuit breaker shall be designated "normal" for

supply to the SES bus load and GMDB "PV" circuit breaker shall be designated "standby," to supply the GMDB bus load during emergency and service outage conditions. Circuit breakers connecting the two power sources to the load bus shall be controlled by a remote microprocessor-based multiple-generator and PV paralleling microgrid monitoring and control system. Power for the transfer control shall be from the emergency system.

2. In automatic mode, the utility source is healthy and the SES load bus is connected to the SES "PV" source as normal operation. . When the utility source fails, the control shall automatically open the SES "PV" (normal) power source before closing the GMDB "PV" (standby) source circuit breaker.
3. Sequence of Operation:
   a. See Section 262313 "Paralleling Low-voltage Switchgear" for remote control circuit breaker management.
4. Field-Adjustable Transfer Parameters:
   a. Delay the transfer from the SES "PV" (normal) power source to the GMDB "PV" (standby) power source and from the GMDB "PV" (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: zero 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. Minimum Delay range: zero seconds to 120 seconds.
   c. Delay the transfer from the standby power source to the normal power source. Delay range: zero 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.
   e. Manual close of SES "PV" circuit breaker shall be restricted when associated GMDB "PV" circuit breaker pair is closed.
5. Controls and Indicators: Besides the delay setting controls, provide the following:
   a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers are tripped due to overcurrent or ground fault.
   b. Transfer-control automatic and manual selector.
      1) Interlock shall prevent paralleling of the two power sources in manual mode.
   c. Open-close control switch for manual electrical operation of each controlled circuit breaker.
   d. Selector to place control into programming mode.
   e. Circuit-breaker control switch for each of the normal and standby source breakers, providing open and close operation.
   f. Push button to initiate manual retransfer to the normal source when the transfer controller is in automatic mode.
6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/32R/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

a. Manufacturer: Subject to compliance with requirements, provide products by the following:
   1) Schweitzer Engineering Laboratories (SEL), Inc.

2.14 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources shall be devised by manufacturer to insure that the proper main or PV breaker(s) operate properly in normal and emergency conditions. Switchgear shall include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to the main bus of the switchgear. Ensure that the following occurs on the main bus:
   1. A ground fault at any location in the switchgear shall trip the system.
   2. Combination of normal current flow and ground-fault current flow shall trip the system.
   3. Circulating currents through the neutral due to multiple grounds and sources external to the immediate low-voltage power sources shall not trip the system.
   4. System shall not trip if there is no ground fault, during normal current flow.
   5. System shall not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:
   1. Factory installed, complete with bundling, lacing, and protection.
   2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   3. Install plugs in control wiring at shipping splits.

2.15 MAINTENANCE TOOLS

A. Description: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

B. Include the following:
   1. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   2. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
   3. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   4. Racking handle to move circuit breaker manually between connected and disconnected positions.

C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

D. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

E. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.16 IDENTIFICATION

A. Compartment Nameplates: Engraved, melamine plastic, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Painted graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

C. Arc-Flash Warning Labels:
   1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
   2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
      a. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
         1) Location designation.
         2) Nominal voltage.
         3) Flash protection boundary.
         4) Hazard risk category.
         5) Incident energy.
         6) Working distance.
         7) Engineering report number, revision number, and issue date.
      b. Labels shall be machine printed, with no field-applied markings.

2.17 SOURCE QUALITY CONTROL

A. Testing: Test and inspect low-voltage switchgear according to IEEE C37.20.1. Drawout circuit breakers need not be tested in the assembly if they are tested separately.
   1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate the ability of the insulation system to withstand the voltages listed in IEEE C37.20.1. The voltage is to be increased gradually from zero to the required test value within 5 to 10 seconds and shall be held at that value for one minute.
   2. Perform mechanical operation tests to ensure proper functioning of operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.

3. Test the effectiveness of grounding of each metal-case instrument transformer frame or case.
4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in the intended sequence. Verify remote control of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers.
5. Perform the control wiring insulation tests.
6. Verify correct polarity of the connections between instrument transformers and meters and relays.

B. All serial communications devices within the equipment shall be addressed at the factory and tested to verify reliable communications to the equipment's Ethernet gateway.

C. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. 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. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. 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 the section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.

D. 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 shall be five ohms at the switchgear location.

E. On delivery of switchgear and prior to unloading, inspect equipment for damage.
1. Verify that tie rods and chains 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 written instructions.
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 comply with manufacturer's written instructions and Shop Drawings. If the shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
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.

F. Handling:
1. Handle switchgear, according to manufacturer's written instructions; 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.

G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3.

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Exterior Locations:
1. Install tinned bare copper conductors not smaller than No. 4/0 AWG, for ground conductors buried not less than 30 inches 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 indicated.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.

5. Fence and equipment connections shall not be smaller than No. 4 AWG.
6. Ground fence at each gate post and corner post and at intervals not exceeding 10 feet.
7. Bond each gate section to the fence post using 1/8-by-1-inch tinned, flexible braided copper strap and clamps.

C. 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.

D. Complete switchgear grounding and surge-protector connections prior to making any other electrical connections.

E. Connect to remote data monitoring and control systems including but not limited to Building Automation System (BAS) networks, multiple-generator and PV paralleling microgrid monitoring and control system networks and PV control system network.

3.4 IDENTIFICATION

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 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter and of NETA ATS.
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 stated in NETA ATS. Certify compliance with test parameters.
4. 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 for high resistance using one of the following two methods:
      1) Use a 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 the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
   1) Attempt closure on locked-open devices. Attempt to open locked-closed 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 that vents are clear.
k. Perform visual and mechanical inspection of instrument transformers according to "Instrument Transformer Field Tests" Paragraph.
l. 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.

5. Electrical Tests:
   a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the bus temperature is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
      1) Insulation-resistance values of bus insulation shall be according to 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 written instructions 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.
   b. Perform a dielectric withstand voltage test on each bus section, phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
      1) 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.

c. Perform insulation-resistance tests on control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's written instruction.
   1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.
d. Control Power Transformers:
   1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Insulation-resistance values of winding insulation shall be according to 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 written instructions 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.
e. 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.
f. 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 1.0-A current 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 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
g. Perform system function tests according to "System Function Tests" Article.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

C. Circuit-Breaker Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that all maintenance devices are available for servicing and operating the breaker.

d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings according to coordination study provided by Owner.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:
   a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's written instructions shall be investigated.
   b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
   d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.

g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
k. Verify operation of charging mechanism. Charging mechanism shall operate according to manufacturer's published data.

D. Instrument Transformer Field Tests:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data complies with the 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 that the unit is clean.
f. Inspect bolted electrical connections for high resistance using one of the following two methods:
1) Use a 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 the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
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. Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000-V dc for one minute. For units with

solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.

b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
c. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by manufacturer or be according to IEEE C57.13.1.
d. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
e. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.5.
f. Perform dielectric withstand tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.9.
g. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
h. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by Engineer in Project Drawings.

3. Electrical Tests of Voltage Transformers:
   a. Perform insulation-resistance tests, winding-to-winding and winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
   b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.
   c. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
   d. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. Dielectric voltage shall be according to NETA ATS, Table 100.9. Test voltage shall 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.
   e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

E. Ground-Resistance Test:
1. Visual and Mechanical Inspection:
a. Verify that ground system complies with the Contract Documents and with NFPA 70, Article 250, "Grounding and Bonding."
b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
c. Inspect bolted electrical connections for high resistance using one of the following two methods:
1) Use a 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 the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
d. Inspect anchorage.
2. Electrical Tests:
a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. Resistance between the main grounding electrode and ground shall 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 the Contract Documents.
c. Inspect physical and mechanical condition.
d. Inspect bolted electrical connections for high resistance using one of the following two methods:
1) Use a 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 the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

F. Metering Devices Field Tests:
1. Visual and Mechanical Inspection:
a. Inspect physical and mechanical condition.
b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a 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 the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to 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 that the unit is clean.
e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:
a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

G. 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 LEDs, 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 according to manufacturer's written instructions.
g. Set the relay according to sequence of operations in Section 262313 "Paralleling Low-Voltage Switchgear" and results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Incorporate relay logic per the sequence of operations described in Section 262313 "Paralleling Low-Voltage Switchgear" and Section 262300 "Low-Voltage Switchgear".
i. 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 according to manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.

c. Check functional operation of each element used in the protection scheme as follows:
   1) ANSI No. 2/62, Timing Relay:
      a) Determine time delay.
      b) Verify operation of instantaneous contacts.
   2) ANSI No. 24, Volts/Hertz Relay:
      a) Determine pickup frequency at rated voltage.
      b) Determine pickup frequency at a second voltage level.
      c) Determine time delay.
   3) ANSI No. 25, Sync Check Relay:
      a) Determine closing zone at rated voltage.
      b) Determine maximum voltage differential that permits closing at zero degrees.
      c) Determine set points of live line, live bus, dead line, and dead bus.
      d) Determine time delay.
      e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.
   4) ANSI No. 27, Undervoltage Relay:
      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) ANSI No. 32, 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) ANSI No. 46, Current Balance Relay:
      a) Determine pickup of each unit.
      b) Determine percent slope.
      c) Determine time delay.
   7) ANSI No. 46N, 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) ANSI No. 47, 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 on removal of voltage when previously set to rated system voltage.

9) ANSI No. 50, Instantaneous Overcurrent Relay:
   a) Determine pickup.
   b) Determine dropout.
   c) Determine time delay.

10) ANSI No. 51, Time Overcurrent:
   a) Determine minimum pickup.
   b) Determine time delay at two points on the time current curve.

11) ANSI No. 64, Ground Detector Relay:
   a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, 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.

13) ANSI No. 87, Differential Relay:
   a) Determine operating unit pickup.
   b) Determine the operation of each restraint unit.
   c) Determine slope.
   d) Determine harmonic restraint.
   e) Determine instantaneous pickup.
   f) Plot operating characteristics for each restraint.

d. Control Verification:
   1) Functional Tests:
      a) Check operation of all active digital inputs.
      b) Check output contacts or SCRs, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
      c) Check internal logic functions used in protection scheme.
      d) On completion of testing, reset minimum/maximum 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.

H. Ground-Fault Protection Field Tests: Evaluate the interconnected system according to switchgear manufacturer's written instructions.
   1. Determine the proper location of the sensors around the bus of the circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.

2. Verify the grounding points of the system to determine that ground paths do not exist that would bypass the sensors. Use high-voltage testers and resistance bridges.
3. Test the installed system for correct response by application of full-scale current into the equipment to duplicate a ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:
   a. A coil around the sensors.
   b. A separate test winding in the sensors.
4. Record the test results on the test form provided with the instructions provided by manufacturer.

I. 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 that equipment nameplate data complies with the Contract Documents.
   e. Inspect physical and mechanical condition.
   f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
   g. Verify that 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 verify that alarms comply with system manufacturer's written instructions.
   c. Measure negative post temperature. This temperature shall comply with manufacturer's published data or IEEE 1188.
   d. Measure charger float and equalizing voltage levels. These levels shall be according to 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 shall be according to manufacturer's published data.
   f. Measure intercell connection resistances.
   g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) shall 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) shall not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
   h. Perform a load test according to 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 shall be equal in magnitude to the voltage measured from negative-to-ground.

J. Switchgear components will be considered defective if they do not pass tests and inspections.

K. 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. Systems function tests shall prove successful execution of full range of sequence of operations.
   1. Develop tests to satisfy the sequence of operations and manufacturer recommended function tests.

B. System function tests shall 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 protective relay database files and logic for execution of system function tests and the full range of sequence of operations.
   4. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Test power transfer sequence of operation step by step for each mode.
   1. Verify operation of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers along with utility required protective relay setting for controlled circuit breakers.
   2. See Section 262313 "Paralleling Low-voltage Switchgear" for additional remote control circuit breaker management testing and sequences of operation to be successfully completed by SES.

D. Switchgear will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, 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 piece of 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 inspection.
1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and that 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 according to recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION

SECTION 262313 - PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Metal-enclosed, low-voltage, circuit-breaker switchgear rated 600 V and less, and associated monitoring and control systems for paralleling standby generators on an isolated bus and for distributing electrical power.

B. Related Requirements:
1. Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19 "Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication, monitoring, and metering requirements.
3. Section 262300 "Low-voltage Switchgear" for interfacing communication, monitoring, metering and remote circuit breaker control requirements.
4. Section 262413 "Switchboards" for interfacing communication, monitoring and metering requirements.
5. Section 262416 "Panelboards" for interfacing communication, monitoring and metering requirements.
6. Section 263100 "Photovoltaic Energy Systems" for interfacing communication, monitoring, production management, load sharing and synchronization requirements of distributed energy resources.
7. Section 263600 "Transfer Switches" for interfacing communication, monitoring, metering and remote circuit breaker control requirements.
8. Section 263213 "Engine Generators" for interfacing communication, monitoring, production management, load sharing and synchronization requirements of distributed energy resources.
9. Section 263233 "Rotary Uninterruptible Power Units" and Section 263353 "Static Uninterruptible Power Supply" for interfacing communication, monitoring and metering requirements.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specification.

B. DDC: Direct digital control.

C. Legally Required: As used in this Section, it shall have the same meaning as used in NFPA 70.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of paralleling low-voltage switchgear.
1. Include technical data on features, performance, electrical characteristics, ratings, and finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, SCADA interface devices, Ethernet interface,and display components.

2. Include rated capacities, operating characteristics, furnished specialties, factory settings, and accessories for individual circuit breakers.
3. Include time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For each type of paralleling low-voltage switchgear.
1. Include dimensioned plans, elevations, sections, details, shipping sections, weights of each assembled section, and required clearances and service space around equipment.
2. Include tabulation of installed devices with features and ratings.
3. Include enclosure types and details.
4. Detail locations for anchor bolts and leveling channels.
5. Show bus configuration with current rating, size, and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
6. Indicate short-time and short-circuit current rating of switchgear assembly.
7. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Detail nameplate legends.
9. Include mimic-bus diagram.
10. Include three-line power wiring diagrams for paralleling low-voltage switchgear, generators, and related equipment showing device terminal numbers.
11. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.
12. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:
    a. Engine generators.
    b. Photovoltaic Energy Systems.
    c. Transfer switches.
    d. Other load-control devices.
    e. Elevator controller in each elevator bank.
    f. BAS system for HVAC control.
    g. SCADA remote terminal unit.
    h. UPS.
    i. Battery systems.
    j. SES circuit breakers.

C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

D. Delegated-Design Submittal: For paralleling low-voltage switchgear.
1. Include design calculations, signed and sealed by a qualified professional engineer, for selecting seismic restraints and for structural analysis of outdoor enclosures, including wind loading.
2. For the differential ground-fault protection scheme. Include wiring diagram of the differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

E. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and peak-shaving modes.

1. Include the following in the description of the automatic-mode sequence of operation:
   a. Programmed sequence of initial generator starting and connection of generators to the isolated paralleling bus, including a description of how the proposed design complies with the requirements for redundancy.
      1) Programmed sequence describing PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time.
   b. Programmed sequence of transferring loads to the isolated paralleling bus based on operator-adjustable preset priorities and preset loads. Include initial load settings.
   c. Programmed sequence of starting and stopping generators based on actual real-time measured loads.
      1) The PV power contribution shall not impact the requirement to maintain a total connected generator capacity that exceeds the facility load at all times.
      2) Programmed sequence of connecting PV to the generator bus.
      3) Programmed sequence of connecting PV to the normal service entrance switchgear bus.
   d. Programmed sequence of sending a load-shed signal to transfer switches, and to other devices when the generator frequency does not return to the normal frequency within the adjustable time period.
   e. Programmed sequence of stopping generators based on no transfer switch or other device sending a start signal.
   f. Programmed sequence of connecting and disconnecting PV from the generator bus.
   g. Programmed sequence of connecting and disconnecting PV from the normal service entrance switchgear bus.
2. Include the following in the description of the system testing mode sequence of operation:
   a. Load.
   b. No load.
3. Include in the description, the peak-shaving-mode sequence of operation.
4. Include in the description, the manual-mode sequence of operation showing that the manual mode fulfills the requirement to permit the operator at the paralleling low-voltage switchgear to accomplish all automatic, system test, and peak-shaving functions.
5. Paralleling Low-Voltage Switchgear Redundancy: Identify any single points of failure.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
   1. Floor plans showing dimensioned layout, required working clearances, and required area above and around paralleling low-voltage switchgear where pipe and ducts are prohibited.
   2. Switchgear layout and relationships between components and adjacent structural and mechanical elements.

3. Support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For testing.

C. Seismic Qualification Data: Certificates, for paralleling low-voltage switchgear, overcurrent protective devices, accessories, and components to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
1. Basis of 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. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

B. Operation and Maintenance Data: For paralleling low-voltage switchgear and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Manufacturer's written instructions for sequence of operation.
b. Manufacturer's system checklists, maintenance schedule, and maintenance log sheets complying with NFPA 110.
c. Manufacturer's written instructions for testing and adjusting relays.
d. Time-current curves, including selectable ranges for each type of overcurrent protective device.

C. Training Video: Copy of video recorded training.

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. Control Power Fuses: Six of each type and rating used. Include spares for the following:
a. Potential transformers.
b. Control power circuits.
2. Indicating Lights: Six of each type installed.
3. Draw-out Circuit Breakers: One of each type and rating used for circuit breaker in the paralleling low-voltage switchgear.

B. Maintenance Tools: Furnish tools and miscellaneous items required for paralleling low-voltage switchgear test, inspection, maintenance, and operation. Include the following:
   1. Floor-running transport or dockable dolly with manual lifting mechanism and all other items necessary to remove circuit breaker from housing and transport it to remote location.
   2. Racking handle to move circuit breaker manually between connected and disconnected positions.

C. System Power Riser Diagram: Post on the wall at location, using non-fugitive ink on high-quality paper. (Add. A)

1.7 QUALITY ASSURANCE

A. Testing Qualifications: Accredited by NETA.
   1. Testing Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver paralleling low-voltage switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store paralleling low-voltage switchgear indoors in clean dry space with uniform temperature to prevent condensation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
   1. Ambient temperature not exceeding 104 deg F.
   2. Altitude of 5,200 feet above sea level.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace paralleling equipment that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Two year(s) 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for paralleling low-voltage switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. The multiple-generator and PV paralleling microgrid monitoring and control enclosure shall monitor and control the following emergency and standby power system components:
   1. Paralleling low-voltage switchgear.
   2. Single-generator monitoring and control system.
   3. Single-generator paralleling monitoring and control systems that are part of the paralleling low-voltage switchgear.
   4. Engine generators.
   5. Photovoltaic arrays.
   6. Transfer switches.
   7. Remote Service Entrance Switchgear (SES) "main" and "PV" circuit breakers. See section 262300 "Low-voltage Switchgear" for additional remote circuit breaker control requirements.
   8. Remote circuit breakers.
   9. Other load-control devices.
   10. Relay devices.
   11. Distribution circuit breakers and trip units in paralleling low-voltage switchgear.
   12. Uninterruptible power units and supply equipment.
   13. Fuel tanks.
   14. Comply with Section "260913 Electrical Power Monitoring and Control" requirements to establish the multiple-generator and PV paralleling microgrid monitoring and control system as the facility SCADA.

D. The multiple-generator and PV paralleling microgrid monitoring and control panel shall maintain uninterrupted power supply by the battery system for use as 24/7 facility SCADA. See Section 260913 "Electrical Power Monitoring and Control" for additional SCADA monitoring, control and operator display requirements.

E. Redundant Standby Power System:
   1. Single generator with associated single-generator paralleling monitoring and control system.
   2. Black-start controller with backup control in the multiple-generator paralleling monitoring and control system.
   3. Multiple-generator and PV paralleling microgrid monitoring and control system shall automatically be performed by a backup system without degradation in the event that primary system fails to function for any reason (such as component failure or off-line maintenance), except for the following manually operated functions:
      a. Load management.
      b. Peak shaving.

F. Sequence of Operation for Normal Conditions:
   1. Paralleling low-voltage switchgear, including controlled generators, controlled circuit breakers, and transfer switches, shall be in the automatic position and ready to operate on loss of power or other designated initiation conditions.
      a. The GMDB load circuit breakers are closed.
      b. The GMDB source circuit breakers are open (including generator, PV and docking station).
      c. The GMDB load (ATS & Fire Pump) feeder circuit breakers are closed.

d. The SES "PV" and GMDB "PV" circuit breakers are electrically interlocked. The GMDB "PV" circuit breaker is electrically restricted from closing unless the associated SES "PV" circuit breaker is locked open.

2. Each single-generator monitoring and control system has not received a "start" signal from the following:

a. Transfer switch.
b. Multiple-generator and PV paralleling microgrid monitoring and control system.

G. Sequence of Operation for Loss of Normal Power Conditions:

1. Each single-generator monitoring and control system shall receive a start signal from a redundant system.
   a. Start signal may come from a transfer switch or other device directly wired to start each engine generator.
   b. Start signal may come from the multiple-generator paralleling monitoring and control system that monitors loss of normal source availability from one or more transfer switches or other device.
2. On receiving a start signal, each single-generator monitoring and control system shall start engine generators and achieve rated voltage and frequency.
3. If engine generator fails to start, after expiration of overcrank time delay, engine generator shuts down and alarm is initiated.

4. Transfer Inhibit Control: Multiple-generator and PV paralleling microgrid monitoring and control system receives loss of normal source availability signal from transfer switch(es) or other device and sends transfer inhibit signals.
   a. Transfer switch(es) serving emergency loads shall not be sent a transfer-inhibit signal.
   b. Transfer switch(es) serving other than emergency loads that must transfer within a required time shall have the transfer-inhibit signal end at such a time as will permit transfer switch to operate within required time.
   c. Transfer switch(es) serving other than emergency loads that are not required to transfer within a required time shall be sent a transfer-inhibit signal.
   d. Transfer switch(es) serving loads that are to be disconnected after detecting loss of normal source availability shall signal the associated circuit breakers and other load devices to de-energize these predetermined loads.
   e. Transfer switch(es) serving HVAC loads that need to operate at a lower load by modifying the HVAC sequence of operation after detecting loss of normal source availability shall signal the BAS system for HVAC to change to the HVAC load-shed sequence of operation for the associated equipment.
   f. Transfer switch(es) serving elevator loads after detecting loss of normal source availability shall signal the associated elevator controllers that the elevators are connected to generator power and shall initiate the sequence of operation in the elevator control system to protect the elevators and to reduce elevator load demand.

g. Distribution circuit breakers in the paralleling low-voltage switchgear, which are indicated in a priority-load schedule to transfer load by opening and closing the circuit breaker, receive an inhibit closing signal.

5. Black-Start Control: Prevent out-of-phase paralleling. After selecting the first generator to achieve 90 percent rated voltage and frequency, inhibit the connection of generator-controlled circuit breakers to the isolated paralleling bus, then close the circuit breaker connecting the first generator to the isolated paralleling bus.
   a. Redundant System: Multiple-generator paralleling monitoring and control system selects the first engine generator to connect to the isolated paralleling bus.
6. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
   a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time.
7. After the generators of a capacity greater than the connected load are connected to the isolated bus and all ATS have connected to the isolated emergency bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall monitor available PV power via communication with the PV control system. After the gensets have been added to the isolated emergency bus, the GMDB PV source circuit breakers close to allow for PV system inverters to synchronize to the generators and contribute to the isolated emergency bus.
   a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.
8. When PV sources contribute to total backup source capacity, each generator shall assume its proportional share of total load to allow for PV contributions to reduce fuel consumption.
9. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
10. Failure of an Engine Generator to Synchronize: If engine generator fails to synchronize, sound an alarm after a preset time delay, but continue to attempt to synchronize the engine generator until signaled to stop by manual operation.

H. Priority Controller Sequence of Operation:
   1. Programming from Human-Machine Interface for Priority Controller:
      a. Set priority blocks of load that indicate priority number and scheduled size of load from the Priority-Load Schedule. Set generator blocks of capacity that indicate the individual engine generators and their capacity.
      b. The signal to transfer loads to the engine generator source may be accomplished by one of the following:

1) Signaling to transfer-inhibit enable the transfer switch associated with the priority load to transfer the load.
2) Signaling the load-add relay at the transfer switch to transfer the priority load.
3) Closing the distribution-feeder circuit breaker associated with the priority load.
4) Enabling another device.

2. When generator has transferred Priority 1 emergency load, send signal to transfer loads that must be transferred within a specific time according to the Priority-Load Schedule.
3. When generator capacity is adequate to support next priority load, send signal to transfer next priority load to generator source until all priority loads have been transferred.
4. Available PV source power is added after all load priorities have been added to the emergency bus and the generator system has established a stable system with a total generator capacity that exceeds the facility load.

I. Overload Sequence of Operation:
1. Signal to shed loads from generator source may be accomplished by one of the following:
   a. Signaling load-shed relay in a transfer switch associated with the priority load.
   b. Opening distribution-feeder circuit breaker associated with the priority load.
   c. Disabling another device.
2. Overload sequence of operation sends signal to shed lowest connected load priority when isolated paralleling bus frequency does not return to normal frequency within its adjustable time period.
3. If isolated paralleling bus does not return to normal frequency after shedding lowest connected priority load within adjustable time period, additional load continues to be shed by signaling to load shed in reverse priority until isolated paralleling bus returns to normal frequency.
4. Loads shed can be reconnected to isolated paralleling bus automatically by manual reset at human-machine interface.

J. Load-Demand Sequence of Operation (Generator):
1. With load-demand sequence of operation activated, controller continuously monitors total isolated paralleling bus load.
2. If isolated paralleling bus load is below preset limits and after a preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating to cover (exceed) the total bus load, while the available PV power sources are contributing to reduce fuel consumption of online generators while the total connected generator capacity is always greater than total bus demand load. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.

a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time. Pre-set generator limits related to shutdown shall be independent of and unrelated to PV contribution.

3. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
   a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time. Pre-set generator limits related to shutdown shall be independent of and unrelated to PV contribution.

K. Load-Demand Sequence of Operation (Common Bus):
1. With load-demand sequence of operation activated, controller continuously monitors isolated paralleling bus load at points between sources and loads.
2. If isolated paralleling bus capacity is detected to be overloaded for a segment of bus, after a preset time delay the demand controller initiates overload sequence of operation for ATS associated with bus segment overload.
   a. Manufacturer shall recommend preset time delay based on generator damage and selective coordination performance characteristics. See Section 263213 "Engine Generators" and Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section260573.16 "Overcurrent Protective Device Coordination Study", and Section260573.19 "Overcurrent Protective Device Arc-Flash study" for power studyperformance requirements for equipment ratings and component adjusting.
3. On sensing available isolated bus capacity (after a preset time delay) for the previously overloaded segment of bus, the demand controller shall remove overload sequence of operation signal and resume loss of normal power conditions and connect the shed load as described in the overload sequence of operation.

L. Individual Transfer Switch Return to Normal Condition Sequence of Operation: Enable individual transfer switches to return to normal power when normal power is available at the transfer switch.

M. Circuit Breakers in Paralleling Low-Voltage Switchgear Return to Normal Condition Sequence of Operation: When normal power is available at transfer switches served by feeder circuit breaker, open circuit breaker.
1. GMDB and SES PV circuit breaker pairs shall be open transition and electrically interlocked to restrict simultaneous closure of GMDB and SES PV circuit breaker pairs.
2. Control SES "main" circuit breaker as required to satisfy utility requirements.

N. Individual Circuit Breaker or Other Load Device for Loads Controlled Downstream from Transfer Switch Sequence of Operation: Return circuit breaker or other load device to closed position when transfer switch serving circuit breaker has returned to normal power.
1. Remotely managaed SES PV circuit breaker shall be closed only when the associated GMDB PV circuit breaker is open.

O. Return to Normal Condition Sequence of Operation:
   1. Process starts on removal of start signals from system. Multiple-generator and PV paralleling microgrid monitoring and control system detects removal of loss of normal source availability signal and sequentially adds priority loads to the the SES bus to avoid overloading SES main circuit breaker. Coordinate the Transfer Inhibit Control for ATS for utility loss and restoration transfer avoid overload of SES and GMDB source circuit breakers.
   2. When no load remains on isolated paralleling bus, all PV and generator breakers open, and the generators go through cool-down period, and shut down.
   3. If start signal is received during cool-down period, one engine generator is reconnected to isolated paralleling bus, and system operation follows that of "loss of normal power."
   4. After each ATS has connected to the SES isolated bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall close the SES "PV" circuit breakers and allow for PV contribution to SES bus (normal operation).
      a. Remotely managaed SES PV circuit breaker shall be closed only when the associated GMDB PV circuit breaker is open.

P. Generator System Test Sequence of Operation:
   1. Configure tests to comply with NFPA 110, Level 1 testing requirements for each generator. Automatically generate NFPA 110, Level 1 reports.
   2. Single-generator test.
   3. Multiple-generator test.
   4. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from multiple-generator and PV paralleling microgrid monitoring and control system.
   5. Engine generator(s) start and achieve rated voltage and frequency.
   6. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
   7. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
   8. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.

9. Manually select or automatically preselect whether test is a load or no-load test. If test is a load test, manually select or automatically preselect loads to be transferred according to schedule or by adjustable time delays at transfer switches. After generators are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices. If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.
10. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
11. After adjustable period of time the system, allow engine generators to optimize down to only the required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
12. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to the isolated paralleling bus to accommodate load.
13. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.
14. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal any engine generator that is not currently operating to start, and cancel system test.

Q. Microgrid System Test Sequence of Operation:
1. Configure tests to comply with NFPA 110, Level 1 testing requirements for each generator. Automatically generate NFPA 110, Level 1 reports.
2. Multiple-generator and PV source test.
3. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from multiple-generator and PV paralleling microgrid monitoring and control system.
4. Engine generator(s) start and achieve rated voltage and frequency.
5. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
6. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
7. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.

8. After the generators of a capacity greater than the connected load are connected to the isolated bus and all ATS have connected to the isolated emergency bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall monitor available PV power via communication with the PV control system to achieve PV synchronization with gensets. Upon achieving in-sync voltage and frequency, the multiple-generator and PV paralleling microgrid monitoring and control system adds the available PV sources to the isolated paralleling bus by closing the associated circuit breaker in the paralleling switchgear.
9. Manually select or automatically preselect whether test is a load or no-load test. If test is a load test, manually select or automatically preselect loads to be transferred according to schedule or by adjustable time delays at transfer switches. After generators and PV are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices. If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.
10. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
11. After adjustable period of time the system, allow engine generators to optimize down to only the required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
    a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.
12. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to the isolated paralleling bus to accommodate load.
    a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.
13. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.
14. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal any engine generator that is not currently operating to start, and cancel system test.

R. Start engine generators manually through human-machine interface or by remote contact initiated from a peak-shaving command from BAS system for HVAC.
    1. Engine generator(s) start and achieve rated voltage and frequency.

2. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
3. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.
4. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
5. Failure of Engine Generator to Synchronize: If generator set fails to synchronize, sound an alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
6. Through human-machine interface manually select or on closure of contact from the peak-shaving command preselected loads to be automatically transferred to isolated paralleling bus. After engine generators are connected to isolated paralleling bus, transfer loads by sending signal to corresponding load-add relays that are connected to remote transfer to generator source control input at transfer switch or similar control devices. Add loads until contact closure from BAS system for HVAC opens.
7. After adjustable period of time, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through the human-machine interface panel device and allow settings based on manual priorities or by engine run time.
8. If the isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
9. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
10. After peak shaving is completed, transfer loads back to normal power. Shut down system using sequence in automatic mode.
11. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send, send load-shed signals to lower-priority loads until load is below the engine generator capacity, signal generators that are not currently operating to start, and cancel system peak-shaving operation.
12. Manual Sequence of Operation: Include functions indicated for automatic mode, except that operator shall be able to monitor parameters and manually perform the operations.

S. Comply with NFPA 110 for the following:
   1. Emergency: EPSS Level 1, Type 10.

T. Comply with NFPA 99 for healthcare applications.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Paralleling low-voltage switchgear 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."

B. Structural Performance: Paralleling low-voltage switchgear outdoor enclosures shall comply with locally adopted codes for gravity and wind loads.

C. During normal power conditions, the multiple-generator and PV paralleling microgrid monitoring and control system shall utilize available source PV production to reduce facility utility power consumption.

D. During normal loss of power conditions, the Load Demand sequence of operations and multiple-generator and PV paralleling microgrid monitoring and control system load sharing shall utilize available source PV production to reduce connected generator fuel consumption.

2.3 MULTIPLE-GENERATOR AND PV PARALLELING MICROGRID MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Electric Power Division.
   2. Cummins Power Generation.

B. Source Limitations: Obtain multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
   1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
   2. The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.
   3. The project shall have all circuit breakers supplied by the same manufacturer.

C. Components and Devices: Factory mounted in a metal-enclosed, paralleling low-voltage switchgear and master control section in separate switchboard.
   1. Paralleling Low-Voltage Switchgear Door-Mounted Control Devices: Industrial, oil-type devices.
   2. Indicator Lamps: High-intensity digital display.

D. Control Power for Multiple-Generator and PV Monitoring and Control System: Supplied from 24-V dc starting batteries of engine generators.
   1. Isolate each battery bank to prevent failure of one battery from disabling entire system.

2. Includeseparate control power battery system rated 24-V dc for equipment due to unacceptable voltage drop that occurs during engine cranking between Gen-set and Multiple-Generator and PV Monitoring and Control System.

E. Multiple-generator monitoring and control system auto/manual selector switch.

F. Control switch for circuit breaker that serves load bank.

G. Full-Color, Touch-Screen, Human-Machine Interface Device:
1. Minimum viewing area of 100 sq. in. shall be configurable in either U.S. standard or SI (metric) units.
2. Main Menu: Include date, time, and system status messages. Configure screens so that no screen is more than three touches from any other screen.
    a. Individual engine generator data shall be accessed at the paralleling low-voltage switchgear from the main menu and each single-generator paralleling monitoring and control system.
3. One-Line Diagram: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators.
    a. Conditions for Engine Generators, Buses, and Paralleling Circuit Breakers: Energized or de-energized.
    b. Engine Generator Modes:
        1) Auto.
        2) Lockout.
        3) Reset.
        4) Off.
        5) Cool down.
        6) Test off line.
        7) Test on load.
    c. Engine Generator Status: Normal, warning, shutdown, or load-demand stop.
    d. Paralleling Circuit-Breaker Status: Open, closed, or tripped.
    e. Bus Conditions: Energized or de-energized.
    f. Percent load.
4. AC metering screen for isolated paralleling bus shall display the following:
    a. Phase, volts, and amperes.
    b. Kilowatts.
    c. Kilovolt amperes.
    d. Kilovolt-ampere rating.
    e. Power factor.
    f. Frequency.
    g. Kilowatt hour.
    h. Kilowatt demand.
    i. Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
    j. A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and a minimum duration of four hours.

k. Percent of available capacity of the engine generators that are operating in parallel on the bus.

5. Engine Generator Monitoring and Control Screen:
   a. Control:
      1) Engine generator manual start/stop control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) Engine generator alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit controls.
      4) Engine function and timer settings.
      5) System function, testing, and timer settings.
      6) Engine generator optimization settings: automatically determine the priority of the engine generators based on engine run time and number of engine starts or manually assign engine priorities.
   b. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Engine run hours.
      3) Engine status.
      4) Number of generator circuit-breaker operations.
6. PV Monitoring and Control Screen:
   a. Control:
      1) PV manual start/stop (connect/disconnect) control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) PV alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit controls.
      4) System function, testing, and timer settings.
   b. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Array and inverter status.
      3) Number of PV circuit-breaker (GMDB and SES) operations.
7. Circuit Breaker & Relay Monitoring and Control Screen:
   a. Screen shall include GMDB, SES and other low voltage power circuit breaker and molded case circuit breaker trip unit data as described in other specification sections and on Drawing E7.10 Matrix.
   b. Control:
      1) Circuit Breaker manual open/close control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) Circuit Breaker alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit (open/close) controls.
      4) System function, testing, and timer settings.
   c. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.

2) Circuit-breaker status and circuit-breaker controls status.
3) Metering data.
4) Additional characteristics from Drawing E7.10 Matrix.

8. ATS Monitoring and Control Screen:
   a. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Statuses: See Section "263600" Remote Annunciator and Monitoring Control System requirements.
         a) Inidication of sources available, as defined by actual pickup and dropout setting of transfer-switch controls.
         b) Indication of switch position.
         c) Indication of switch position.
         d) Indication of switch in test position.
         e) Indication of failure of digital communication link.
         f) Key-switch or user-code access to control functions of panel.
         g) Control of switch-test initiation.
         h) Control of switch operation in either direction.
         i) Control of time delay bypass for transfer to normal source.
      3) Alarms.
      4) Additional characteristics from Drawing E7.10 Matrix.
9. UPS Monitoring Screen:
   a. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) UPS, circuit breaker and battery status.
         a) Mode of operation. See Section "263233" and Section "263353" for modes of operation to be displayed remote from UPS.
         b) Alarms. See Section "263233" and Section "263353" for alarms to be displayed remote from UPS.
      3) Additional characteristics from Drawing E7.10 Matrix.
10. System function, testing, and timer settings.
11. Three-Phase, Metering Screen: Graphical analog (270 electrical degree) metering representation with digital display. Display all generators and PV with the isolated paralleling bus and remotely managed ATS and SES circuit breakers (PV and Main) at the same time. Display graphical synchroscope when one generator and the isolated paralleling bus are selected.
    a. True rms, three-phase voltage, amperes, kilowatts, kilovolt amperes, kilovolt-ampere reactive, power factor, and frequency parameters.
    b. Engine battery voltage display.
12. Password-Protected System Control Screen:
    a. System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
    b. Test with Load: Starts and synchronizes engine generators on isolated paralleling bus and then synchronizes available PV sources on isolated paralleling bus; all loads are transferred to the isolated paralleling bus.

c. Test without Load: Starts and synchronizes engine generators on isolated paralleling bus and then synchronizes available PV sources on isolated paralleling bus but does not transfer loads to the isolated paralleling bus.
d. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

13. Password-Protected, Peak-Shaving Control Screen:
    a. Peak-Shaving Modes: Manual start and transfer of loads; automatic start and transfer of loads by DDC system for HVAC peak-shaving relay closure.
    b. For automatic mode, set load priorities for peak-shaving function.
    c. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.
14. Load-Demand Control Screen: Monitors total load on the isolated paralleling bus and controls number of engine generators running so that capacity tracks load demand (and maintains total connected generator capacity to exceed load demand regardless of PV contribution).
    a. Load-Demand Control: Enable/disable.
    b. Set engine generator shutdown sequence.
    c. Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
    d. Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.
15. Manual Load Control Screen: Allows operator to manually add or delete engine generators or PV sources from paralleled system in response to system load parameters.
    a. Indication of system available in kilowatts and amperes.
    b. Control functions allow manual addition/removal of engine generators on system, and activation of load-shed/load-restore functions.
    c. Control functions allow manual addition/removal of PV sources on system.
16. Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:
    a. Display sequence.
    b. Assigns "load-add sequence priority" to each load-control relay with designation for relay operation after a set number of engine generators are online.
    c. Assigns "load-shed sequence priority" to each load-control relay with designation for relay operation depending on number of engine generators online.
17. Alarm Summary and Run Report Screen:
    a. Lists most recent alarm conditions and status changes.
    b. Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
    c. For each start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual engine generators.
    d. Lists generator circuit position and status.
    e. Access to trend all monitored automatic transfer switches.

f. 16-gigabyte hard-disk space for storing the database file for multiple-generator paralleling monitoring and control panel trending and event logging. Trend and log data at a resolution of one second. If hard drive is full, overwrite in a first-in-first-out procedure.
   1) Trend up to eight monitored points simultaneously.

18. Load Status and Control Screen: Displays status of automatic transfer switches connected to the system for 64 transfer switches, and other controlled devices.
    a. Automatic transfer switch connected to normal.
    b. Automatic transfer switch connected to emergency.
    c. Controlled circuit breakers downstream from the automatic transfer switch device enabled or disabled.
    d. Engine start indication.
    e. Load-shed indication.
    f. Load-add indication.
    g. Inhibit to emergency source.
    h. Inhibit to normal source.
    i. Transfer Switch Power Metering Function: Total kilowatt, three-phase current, and three-phase voltage.
    j. Automatic Transfer Switch Load Priority: Ability to change priorities of automatic transfer switches (password protected).
    k. Display name, status, and priority of each load block (whether on or off) and the total load of that block.
    l. Allow for manually adding or shedding loads.
19. Automated email messages shall be transmitted when shutdowns occur and shall include time and date of alarm.
20. Based on either the number operations or the time since the last maintenance, suggest maintenance period for generator (run hours), controlled circuit breaker (number of operations), and transfer switches (number of transfers).
21. Status and Alarm Screen:
    a. Visual alarm status indicator and alarm horn with silence and acknowledge push button.
    b. Status, Light Only:
       1) "SYSTEM NOT IN AUTO" (red).
       2) Running Status: Display engine generator number and running-status light (green).
       3) Load-demand mode (green).
       4) Priority Load Status: Display load number with "LOAD ADD" (green) and "LOAD SHED" (red).
       5) System test (green).
       6) Remote system start (red).
       7) Monitoring of Each Transfer Switch:
          a) Normal source available for each (green).
          b) Connected to normal (green).
          c) Generator source available (green).
          d) Connected to generator source (green).
    c. Status Light and Alarm:
       1) Isolated paralleling bus under frequency (red).

2) Isolated paralleling bus over frequency (red).
3) Auxiliary power failure (red).
4) Emergency start signal power failure (red).
5) Load-Shed Level Status: Displays load number and red load-shed, status light.
6) Generator Alarm Status: Displays generator number and red "Check Generator" status light.
7) Controller malfunction (red).
8) Check station battery (red).
9) Isolated paralleling bus overload (red).
10) System not in auto (red).
11) Main tank, low fuel (amber)
12) Main tank, high fuel (amber).
13) Main tank, fuel leak (red).

H. Remote Monitoring: Replicate human-machine interface monitoring functions at remote computer terminal via communication bus.

I. Remote Monitoring of Status and Alarms: Replicate human-machine interface status and alarms at BAS system for HVAC via isolated contacts and communication link via BACnet protocols.

J. Comply with Section "260913 Electrical Power Monitoring and Control" requirements to establish multiple-generator and PV paralleling microgrid monitoring and control system as the facility SCADA.

2.4 SINGLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.

B. Source Limitations: Obtain single and multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.

C. Components and Devices: Factory mount in each single-generator section of the metal-enclosed, paralleling low-voltage switchgear.
1. Paralleling low-voltage switchgear door-mounted control devices shall be industrial oil-type devices. Indicator lamps shall be high-intensity digital display.

D. Control Power: Supply control power from the 24-V dc starting batteries from the controlled generator. Include separate control power battery system rated 24-V dc for any equipment unable to accept the voltage drop that occurs during engine cranking.

E. Programmable Logic Controller: Factory-mounted controller, separate from the multiple-generator paralleling monitoring and control system in each single-generator paralleling monitoring and control module of the metal-enclosed, paralleling low-voltage switchgear.

F. Single-Generator Paralleling Low-Voltage Switchgear Circuit Breaker:
   1. Factory mount the circuit-breaker control switch.
   2. Paralleling Circuit-Breaker Monitor and Control:
      a. Monitors circuit-breaker auxiliary contacts.
      b. Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
      c. Trips open and locks out paralleling circuit breaker on paralleling circuit breaker failure to close, until manually reset.

G. Generator Mode Selector Switch: Factory mounted in the single-generator paralleling monitoring and control system module of the metal-enclosed, paralleling low-voltage switchgear.
   1. "Lockout/Reset" mode prevents generator from starting or immediately shuts down generator if running.
   2. "Off/Cool-Down" mode stops engine after a cool-down period.
   3. "Auto" mode allows generator to start on receipt of remote start signal. If the generator is already running and there is not a start signal, then "Auto" mode allows engine to run for predetermined cool-down period before stopping.
   4. "Test Off-Line" allows engine to start and run as if a start signal were received, except it does not allow generator to connect to the isolated paralleling bus unless a start signal is received.
   5. "Test Online" allows the engine to start, run, and connect to the isolated paralleling bus as if a start signal were received.

H. Engine Generator Controller: Woodward compatible.

   1. Factory mount governor (speed control and load sharing) supplied in applicable engine generator Section in single-generator monitoring and control module.
   2. Loading control interface to the governor system.
   3. Automatic synchronizer.

I. Automatic Synchronizer:
   1. Include sync mode selector switch with RUN-OFF-CHECK-PERMISSIVE positions. In RUN mode, enable active synchronization and sync-check function. In CHECK mode, perform the sync-check function. In PERMISSIVE mode, annunciate when generator and bus are synchronized but do not allow breaker closure.
      a. Include discrete inputs in synchronizer to switch to each mode.
   2. Bias the generator speed and voltage to match the paralleling isolated bus.
   3. If the automatic synchronizer receives a permissive signal to allow closure to the paralleling isolated bus and the generator is within synchronizing limits, send a close signal to the single-generator paralleling circuit breaker.

J. Sync-switch, removable, keyed T-handle.

K. "Engine Generator Synchronized" Indication: Indicator lamp or digital-display indication of synchronization.

L. Voltage and Frequency Raise and Lower Switches: Allow plus or minus 5 percent adjustment when engine generator is operating but is not connected to the isolated paralleling bus.

M. Control and Reset Push Button: Have flashing lamp to indicate generator is locked out due to fault condition.

N. Lamp Test Push Button: Simultaneously tests all lamps on panel.

O. Control Panel Illumination: DC lamps illuminate panel when lighting from surrounding environment is unavailable.

P. Emergency Stop Push Button: Red mushroom-head switch maintains its position until manually reset.

Q. Alarm and Status Indicating Display:
1. Status and Alarm Indications:
a. Status, Light Only (Nonlatching):
1) Generator mode selector switch not in auto (red).
2) Generator mode selector switch in auto (green).
3) Start signal received (green).
4) Emergency stop activated (red).
5) Demand mode standby (green).
6) Timing for start (green).
7) Timing for shutdown (green).
8) Generator circuit breaker closed (red).
9) Generator circuit breaker open (green).
a) Generator circuit breaker locked out (white).
b) Generator circuit breaker racked out (white)
10) Remote generator breaker is open (red).
11) Engine stopped (green).
12) Time-delay start (green).
13) Engine running (red).
14) Engine cool-down (green).
b. Pre-Alarm, Light and Horn (Nonlatching):
1) Pre-high coolant temperature (amber).
2) Pre-low oil pressure (amber).
3) Low coolant temperature (amber).
4) Engine low battery (amber).
5) Battery charger failure (amber).
6) Auxiliary power failure (amber).
7) Low fuel-day tank (amber).
8) Paralleling low-voltage switchgear generator breaker failed to close (amber).
9) Paralleling low-voltage switchgear generator breaker failed to open (amber).
10) Overcurrent alarm (amber).
11) Day tank low-fuel alarm (amber).

12) Ground-fault alarm (amber).

c. Shutdown Alarm, Light and Horn (Latching):
1) Engine overcrank (red).
2) Engine overspeed (red).
3) Engine low oil pressure (red).
4) Engine high coolant temperature (red).
5) Engine low coolant level (red).
6) Engine remote emergency shutdown (red).
7) Generator fail to synchronize shutdown (red).
8) Generator circuit breaker tripped (red).
9) Generator circuit breaker failure (red).
10) Generator not in auto (red).
11) Generator loss of field (red).
12) Generator reverse power (red).
13) Generator undervoltage (red).
14) Generator overvoltage (red).
15) Generator underfrequency (red).
16) Generator overfrequency (red).
17) Phase rotation (red).
18) Generator short circuit (red)
19) Day tank low-fuel shutdown (red).
20) Air damper activated, shutdown (red).

R. Paralleling Controls and Protection:
1. Engine Generator Governor (Speed Control and Load Sharing): Comply with requirements in applicable engine generator Section. Components shall be Woodward compatible.
2. Kilowatt Load Sharing Control and Interface:
a. Operates engine generator governors during synchronizing and provides isochronous load sharing when paralleled.
b. Allows engine generator to ramp up to kilowatt load level signaled by multiple-generator and PV paralleling microgrid monitoring and control controller.
3. Load-Demand Governing Control:
a. Causes engine generator to ramp down at an operator-adjustable rate to zero load when signaled to shut down in load-demand mode.
b. Causes engine generator to ramp up at an operator-adjustable rate to a proportional share of total isolated paralleling bus load when signaled to restart.
4. Kilovolt-Ampere-Reactive Load Sharing Control:
a. Operates alternator excitation system while engine generator is paralleled.
b. Causes sharing of reactive load among engine generators to within 1 percent of equal levels without voltage drop.
5. Paralleling Monitor and Control:
a. Monitors and verifies that engine generator has reached 90 percent of nominal voltage and frequency before closing to the isolated paralleling bus.

b. Prevents accidental closure of the breaker with the engine generator out of phase with the bus.
c. Prevents out-of-phase closure to the isolated paralleling bus due to errant manual or automatic operation of synchronizer.
d. System of diagnostic digital displays to assist in analyzing synchronization.

6. Synchronizer Control:
   a. Adjusts engine governor to match voltage, frequency, and phase angle of the isolated paralleling bus.
   b. Maintains engine generator voltage within 1 percent of the isolated paralleling bus voltage, and phase angle within 20 electrical degrees of the isolated paralleling bus for 0.5 seconds before circuit-breaker closing.
   c. Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down engine generator on failure condition.
7. Reverse Power Monitor and Control:
   a. Prevents sustained reverse power flow in engine generator.
   b. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse power condition exceeds 10 percent of engine generator kilowatt for three seconds.
   c. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse kilovolt-ampere conditions exceeds 20 percent of generator kilovolt-ampere rating.
8. Phase Rotation Monitor and Control: Verifies engine generator and isolated paralleling bus phase rotation match prior to closing paralleling circuit breaker.
9. Electronic Alternator Overcurrent Alarm and Shutdown Control:
   a. Monitors current flow at engine generator output terminals.
   b. Initiates alarm when load current on engine generator is more than 110 percent of rated current for more than 60 seconds.
   c. Overcurrent shutdown function matched to thermal damage curve of alternator.
10. Electronic Alternator Short-Circuit Protection: Shuts down generator, without instantaneous-trip function, when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator.
11. Loss of Excitation Monitor: Displays alarm on single-generator paralleling monitoring and control panel when generator controls sense loss of excitation to alternator while paralleled to the isolated paralleling bus.
12. Cool-Down, Time-Delay Control: Adjustable, zero to 600 seconds.
13. Start Time-Delay Control: Adjustable, zero to 300 seconds.
14. Frequency Control: Initiate an alarm condition when engine generator is below 90 percent of rated frequency for more than 20 seconds or is over the frequency.
15. Under- and Overvoltage Control: Initiate an alarm condition when the engine generator is at 90 percent voltage for more than 20 seconds or is over the voltage.

2.5 SINGLE-PHOVOLTAIC (PV) PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Electric Power Division.
   2. Cummins Power Generation.

B. Source Limitations: Obtain single-PV and multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
   1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
   2. The multiple-generator and PV paralleling microgrid monitoring and control system shall fully integrate the PV monitoring and control system for load sharing and synchronizing distributed energy resources including but not limited to diesel gensets and the utility sources. See Section 263100 "Photovoltaic Energy Systems" for system integration requirements.

C. Synchronizer (Load Sharing) Control: Per PV requirements. Comply with Section "263100 Photovoltaic Energy Systems" for system integration requirements.

D. Reverse Power Monitor and Control:
   1. Prevents sustained reverse power flow in engine generator or PV.
   2. Trips PV paralleling circuit breaker and initiates PV shutdown when reverse power condition exceeds PV system tolerance.
   3. Trips PV paralleling circuit breaker and initiates PV shutdown when reverse kilovolt-ampere conditions exceeds PV system tolerance.

2.6 METAL-ENCLOSED, CIRCUIT-BREAKER SWITCHGEAR (600 V AND LESS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Electric Power Division.
   2. Cummins Power Generation.

B. Source Limitations: Obtain multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
   1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
   2. The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.
   3. All project circuit breakers shall be by the same manufacturer.

C. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and UL 1558.

D. Ratings: Suitable for application in three-phase, 60-Hz, solidly grounded neutral system.

E. Nominal System Voltage:As shown on Drawings.

F. Isolated Paralleling Bus: Rating as shown on Drawings.
   1. Phase-, Neutral-, and Ground-Bus Materials:
      a. Phase and Neutral Bus: Copper, tin plated.
      b. Ground Bus: Copper, tin plated; minimum size 1/4 by 2 inches.
      c. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with compression connectors for outgoing circuit conductors.
   2. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
      a. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing neutral conductors.
      b. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.

G. Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.
   1. See Section 1.1.B Related Requirements. Switchgear shall be rated for fault current conditions.
   2. As shown on Drawings.

H. Switchgear Fabrication:
   1. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
   2. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
   3. Auxiliary Compartments: Match and align with basic switchgear assembly.
      a. Bus transition sections.
      b. Pull sections.
      c. Hinged front panels for access to accessory and blank compartments.
      d. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
      e. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
      f. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
         1) Sprayed Insulation Thickness: 3 mils, minimum.
         2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
   4. Circuit-Breaker Terminals for Cable Connections: Silver-plated copper bus extensions equipped with compression connectors for conductors.

I. Circuit Breakers: Comply with IEEE C37.13, IEEE C37.16, and IEEE C37.17.

1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   a. Normal Closing Speed: Independent of both control and operator.
   b. Slow Closing Speed: Optional with operator for inspection and adjustment.
3. Stored-Energy Mechanism: Electrically charged, with optional manual charging and operation counter.
4. Trip Devices:
   a. Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, and a release mechanism.
   b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   c. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
   d. Time-Current Characteristics: Field adjustable.
   e. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
   f. Long-Time- and Short-Time-Delay Functions: Three bands, minimum; marked "minimum," "intermediate," and "maximum."
   g. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
   h. Pickup Points: Five minimum, for instantaneous-trip functions.
   i. Ground-fault protection alarm with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
      1) Three-wire circuit or system.
      2) Four-wire circuit or system.
      3) Four-wire, double-ended substation.
   j. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
6. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions.
   a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed.
   b. Circuit-Breaker Positioning:
      1) An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed, unless live parts are covered by a full dead-front shield.
      2) An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open.

3) Status for connection devices for different positions includes the following:
a) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
b) Disconnected Position: Primary and secondary devices and ground contact disengaged.

7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position; arranged to permit inspection of contacts without removing circuit breaker from switchgear.
8. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
9. Operating Handle: One for each circuit breaker capable of manual operation.
a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with the isolated paralleling bus.
10. Electric Close Button: One for each electrically operated circuit breaker.
a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with the isolated paralleling bus.
11. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
13. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
14. Shunt-Trip Devices:
a. 24-V dc for generator paralleling circuit breakers and for distribution paralleling switchgear circuit breakers.
b. Where indicated.
15. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

J. Metering:
1. Type and Locations:
a. Isolated Paralleling Bus: Multifunction digital-metering monitor; on door of separate metering compartment.
b. Generator Circuit Breakers: Multifunction digital-metering monitor; on circuit-breaker door.
c. Distribution Circuit Breakers: Multifunction digital-metering monitor; on circuit-breaker door.
2. Instrument Transformers:
a. Comply with IEEE C57.13.
b. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
c. Current Transformers:

1) Burden and accuracy class suitable for connected relays, meters, and instruments.
2) Size for the maximum momentary current amperage based on calculation or the momentary rating of the circuit breaker protecting the conductor.
3) Include shorting-type terminal blocks.

3. Multifunction Digital-Metering Monitor:
   a. Microprocessor-based unit suitable for three- or four-wire systems.
   b. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   c. Switch-selectable digital display with the following features:
      1) Phase Currents, Each Phase: Plus or minus 1 percent.
      2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      4) Three-Phase Real Power: Plus or minus 2 percent.
      5) Three-Phase Reactive Power: Plus or minus 2 percent.
      6) Power Factor: Plus or minus 2 percent.
      7) Frequency: Plus or minus 0.5 percent.
      8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
      9) Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
   d. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 260913 "Electrical Power Monitoring and Control."
   e. Mounting: Display and control unit that is flush or semirecessed mounted in instrument compartment door.

K. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
   1. Manufacturer: Subject to compliance with requirements, provide products by Schweitzer Engineering Laboratories (SEL) Co.
   2. Functions: As shown on Drawings.

L. Door-Mounted Control Components: Industrial-type oiltight devices and digital-display indicator lamps.

M. Control Power Supply:
   1. Control power transformer shall supply 120-V ac control circuits from the generator source through secondary disconnect devices.
   2. Include a control power transformer for each generator paralleling switchgear circuit breaker connected to the generator side of the circuit breaker.
   3. Include a control power transformer for each distribution paralleling switchgear circuit breaker.
   4. Dry-type transformers shall be in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   5. Control Power Fuses: Primary and secondary fuses shall provide current-limiting and overload protection.

N. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Conductors shall be sized according to NFPA 70 for duty required.

O. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

P. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems" for electrical identification devices and installation.
1. Identify units, devices, controls, and wiring.
2. Mimic Bus: Continuous mimic bus, applied to front of paralleling low-voltage switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   a. Mimic-bus segments coordinated with devices in paralleling low-voltage switchgear sections to which applied, to produce a concise visual presentation of principal paralleling switchgear components and connections.
   b. Medium: Painted graphics, as selected by Architect.
   c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

Q. Indoor Enclosure Material: Steel.

R. Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of paralleling low-voltage switchgear.

S. Finish: Manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

T. Accessories:
1. Tools for circuit-breaker and switchgear tests, inspections, maintenance, and operation.
2. Racking handle to manually move circuit breaker between connected and disconnected positions.
3. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
4. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

U. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of draw-out circuit breaker installed.

V. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

W. Storage for Manual: Rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 CONTROL POWER SUPPLY, 24-V DC

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity shall be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.

B. Battery: Premium VRLA batteries, with battery disconnect and overcurrent protective device.

C. 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.

D. Accessories:
   1. Thermometers with specific-gravity correction scales.
   2. Hydrometer syringes.
   3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall 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.
   1. DC ammeter.
   2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
   3. 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.
   4. 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.
   5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation shall be automatic until manually reset.
   6. 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 shall resume after loss of ac power supply for any interval.
   7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device shall regulate charging current but shall not disconnect charger from either battery or ac supply.
   8. Charger's Audible Noise: Less than 26 dB.

2.8 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources shall be devised by manufacturer to insure that the proper generator or PV breaker(s) operate properly in emergency conditions. Switchgear shall include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to the main bus of the switchgear. Ensure that the following occurs on the main bus:
   1. A ground fault at any location in the switchgear shall alarm the system and not trip the system.
   2. Combination of normal current flow and ground-fault current flow shall alarm the system and not trip the system.
   3. Circulating currents through the neutral due to multiple grounds and sources external to the immediate low-voltage power sources shall not trip the system.
   4. System shall not trip if there is no ground fault, during normal current flow.
   5. System shall not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:
   1. Factory installed, complete with bundling, lacing, and protection.
   2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   3. Install plugs in control wiring at shipping splits.

2.9 IDENTIFICATION

A. Compartment Nameplates: Engraved, laminated acrylic , as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Source labeling: Use unique label to distinguish source (generator, PV) circuit breakers and load (ATS) distribution circuit breakers.

C. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Painted graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

D. Arc-Flash Warning Labels:
   1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
   2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

a. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
   1) Location designation.
   2) Nominal voltage.
   3) Flash protection boundary.
   4) Hazard risk category.
   5) Incident energy.
   6) Working distance.
   7) Engineering report number, revision number, and issue date.
b. Labels shall be machine printed, with no field-applied markings.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect paralleling low-voltage switchgear, with generators and transfer switches, at paralleling low-voltage switchgear manufacturer's or suppliers factory.
   1. Paralleling Low-Voltage Switchgear:
      a. NETA ATS, 7.6.1.2, "Circuit Breaker, Air, Low-Voltage Power Switchgear."
      b. Factory test with simulated inputs. Test control and relay functions for proper operation.
   2. Engine Generator:
      a. NETA ATS, 7.22.1, "Emergency Systems, Engine Generator."
      b. NETA ATS, 7.15.1, "Rotating Machinery, AC Motors & Generator."
   3. Automatic Transfer Switches:
      a. NETA ATS, 7.22.3, "Emergency System, Automatic Transfer Switches."

B. Verification of Performance: Rate paralleling low-voltage switchgear, with generators and transfer switches, according to operation of functions and features specified.

C. Factory test control of paralleling low-voltage switchgear, generators, automatic transfer switches and simulate control of PV and remote (SES "main and "PV") low voltage power circuit breakers to demonstrate successful operation of full range of sequence of operations.

D. Paralleling low-voltage switchgear, with generators and transfer switches, will be considered defective if it does not pass tests and inspections.

E. Coordinate scheduling of the factory witness test with Architect and Owner. Perform successfully tests prior to witness test.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling low-voltage switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and applicable portions in NECA 400.

B. Equipment Mounting:
   1. Install paralleling low-voltage switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3.
   2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from paralleling low-voltage switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:
   1. Frame and mount under clear acrylic plastic on front of paralleling low-voltage switchgear.
      a. Operating Instructions: Printed basic instructions for paralleling low-voltage switchgear, including control and key-interlock sequences and emergency procedures.
      b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
   2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.
   3. Use unique label to distinguish source (generator, PV) circuit breakers and load (ATS) distribution circuit breakers.

3.4 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with wire and cable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Provide all control, distribution, monitoring, and start signal connections as required between relevant equipment.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
   3. Inspect paralleling switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.

4. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
5. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
   a. AC generators and emergency systems.
   b. Switchgear.
   c. Circuit breakers.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.
2. Perform NFPA 100 tests for Type 1 essential power systems.

D. Paralleling low-voltage switchgear will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. 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.

G. Test sequence of operation step by step for each mode.

H. Test the graphical user interfaces for all monitoring points and graphics described in specification and as indicated on Drawings.

3.6 ADJUSTING

A. Set field-adjustable, electronic circuit-breaker trip characteristics according to results specified in Section 260573.16 "Coordination Studies."

B. Set field-adjustable, electronic circuit-breaker trip characteristics.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling low-voltage switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling low-voltage switchgear, according to manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain paralleling low-voltage switchgear.

B. Record the training and provide a video copy to the Owner.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Accessory components and features.
6. Identification.

B. Related Requirements
1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote monitoring and metering requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   4. 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.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.
   7. **Circuit Breakers, all types: Equal to 5 percent of quantity installed for each size and type, but no fewer than four of each size and type.** **(Add. A)**

1.6 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 and store in a way that prevents condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and 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 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

C. 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 seven 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.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

   2. 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 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Section Alignment: Front aligned.

J. Front- and Rear-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel Fixed, individually Fixed and individually compartmented Individually compartmented and drawout mounted.
   3. Sections front and rear aligned.

K. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

      a. 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."

L. Indoor Enclosures: Steel, NEMA 250, Type 1.

M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

N. Barriers: Between adjacent switchboard sections.

O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Fire Pump Tap Section: Full height section, matched and aligned with adjacent switchboard sections.
   1. Tap section shall be sized to accommodate tap for size of fire pump service conductors as indicated on the Drawings.
   2. Tap shall be located on the line side of the service disconnecting means and on the load size of the utility current transformer connections.
   3. Tap section shall contain only the fire pump service tap and conductors and shall not contain any overcurrent protective devices or disconnects.

4. Tap section shall be labeled with permanent identification plaque which reads "FIRE PUMP SERVICE TAP" using white lettering on a red background and shall comply with Section 260533 "Identification of Electrical Systems".
5. Top or bottom entry as indicated on Drawings or as required to coordinate with the location of the outgoing fire pump service conductors.

S. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

T. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

U. 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 the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
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 mechanical 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 the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 1 Type 2.

C. Features and Accessories:
1. Integral disconnect switch.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 200 kA.

G. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. 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 with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long and short time adjustments.
   d. Ground-fault pickup level, time delay, and I squared t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Integral trip unit multifunction metering as required by Drawings. See Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting requirements.
    1) Values shall be rms average over a period of one second.
        a) Current: Each phase, neutral and three-phase average.
        b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
        c) Active Power (kW): Each phase and three-phase total.
        d) Reactive Power (kVAr): Each phase and three-phase total.
        e) Apparent Power (kVA): Each phase and three-phase total.
        f) Power Factor: Each phase and three-phase total.
        g) Active Energy (kWh): Three-phase total.
f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control."
g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

B. Insulated-Case Circuit Breaker (ICCB): 100 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. Standard -function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
        a. Instantaneous trip.
        b. Time adjustments for long- and short-time pickup.
        c. Ground-fault pickup level, time delay, and I squared t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Section 262813 "Fuses."

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

E. Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.

G. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15 -minute integrated demand of totalized system.

2.6 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

D. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

E. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's 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 per manufacturer's 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 the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3
1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
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 concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the 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.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies."

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems."

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. 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 the 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 per 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 an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an 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.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 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."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements
   1. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. Section 262313 "Paralleling Low-voltage Switchgear" for remote monitoring and metering requirements.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

1.4 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 017823 "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.

1.5 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. Circuit Breakers Including GFCI and GFEP Types: Equal to **5** percent of quantity installed for each size and type, but no fewer than **four** of each size and type 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. **(Add. A)**
3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; storage in a dry space with adequate heating to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 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.

PART 2 - PRODUCTS

2.1 PANELBOARDS GENERAL REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. 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.

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, as indicated, 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 Wash-Down Areas: NEMA 250, Type 4X, stainless steel
   d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.

e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. 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.

G. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum for 400 Amp and below; Hard-drawn copper, 98 percent conductivity for 600 Amp and above.
   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. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. 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.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Same as buses.
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. Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

I. NRTL Label: Panelboards 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. 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 minimum short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical where supplied from transformers rated less than 75kVA and not less than 22,000 A rms symmetrical where supplied from transformers rated 112.5kVA or greater. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573.13 "Short-Circuit Study".
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have minimum short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573.13 "Short-Circuit Study".

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD. Provide Type 1 for service entrance equipment; Type 2 for other panelboards as indicated or specified.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

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 high, provide two latches, keyed alike.

D. Mains: As indicated.

E. Branch Overcurrent Protective Devices for Circuit-Breaker:Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal or fused switches as indicated.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

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) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "I" subscript on a circuit breaker:
   a) Instantaneous trip.
2) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "L" subscript on a circuit breaker:
   a) Long-time pickup level.
   b) Long-time time adjustment.
3) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "S" subscript on a circuit breaker:
   a) Short-time pickup levels.
   b) Short-time time adjustment.
4) Where indicated on Drawings with "G" subscript on a circuit breaker or where required by NEC for circuit breakers with frame sizes rated 1000A and greater on 480V and 480Y/277V circuits:
   a) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. Subfeed Circuit Breakers: Vertically mounted.
7. 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. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
   f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   g. Integral trip unit multifunction metering as required by Drawings. See Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting requirements.
      1) Values shall be rms average over a period of one second.
         a) Current: Each phase, neutral and three-phase average.
         b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
         c) Active Power (kW): Each phase and three-phase total.
         d) Reactive Power (kVAr): Each phase and three-phase total.
         e) Apparent Power (kVA): Each phase and three-phase total.
         f) Power Factor: Each phase and three-phase total.

g) Active Energy (kWh): Three-phase total.

h. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting as required by Drawings.

i. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

k. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

l. 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.

m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

o. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

p. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.

q. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

r. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Provide one for each branch circuit overcurrent device serving fire alarm equipment. Handle clamps installed for fire alarm overcurrent devices shall have a red finish.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.

b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.

c. Auxiliary Contacts: OneTwo normally open and normally closed contact(s) that operate with switch handle operation.

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.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

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.
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

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. Install handle clamps on all branch circuit overcurrent devices serving fire alarm equipment.

N. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub three1-inch empty conduits into raised floor space or below slab not on grade.

O. 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 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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 low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. 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.

B. Set field-adjustable circuit-breaker trip ranges per Coordination Study.

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 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.2 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.3 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. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two .
   3. **Receptacles and switches: 5 for every 100, but no fewer than 5.** **(Add. A)**

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 and NEMA WD 6.

E. Devices indicated as "tamper-resistant" shall have integral shutters that operate only when both prongs of a plug are inserted in the receptacle.

F. Devices indicated as "weather-proof" or "weather-resistant" shall have the following:
   1. Spring-loaded, gasketed, metallic, "weather-proof-in-use" cover.
   2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

G. Switches indicated as Key-switch shall have factory-supplied key in lieu of switch handle.

H. Devices indicated or specified as anti-microbial shall have contact surfaces treated with a factory-applied coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.

I. Devices indicated or specified as decorator style shall have a rectangular face opening.

J. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.

2. Cord and Plug Sets: Match equipment requirements.

K. Device Color:
1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

L. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: Heavy-duty, NEMA 5-20R
3. Standards: Comply with UL 498 and FS W-C-596.

B. Isolated-Ground Duplex Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: Heavy-duty, NEMA 5-20R
4. Standards: Comply with UL 498 and FS W-C-596.

2.3 USB RECEPTACLES

A. USB Charging Receptacles:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description:
   a. Receptacle: Duplex 20A, 125V receptacle, configuration 5-20R, with tamper-resistant shutters.
   b. USB Ports: One USB Type A and one USB Type C port with total available charging current of 3.1A or greater at 5 VDC.
3. Standards: Comply with UL 498, UL 1310 and USB 3.0 devices.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Non-feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 HOSPITAL-GRADE RECEPTACLES, 125 V, 20 A

A. Hospital-Grade, Duplex Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

B. Hospital-Grade, Duplex GFCI Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Single-piece, rivetless, nickel-plated, all-brass grounding system.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Non-feed through.

5. Standards: Comply with UL 498 supplement sd, UL 943 Class A, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, amperage, voltage, and NEMA configuration as indicated on the Drawings: Comply with NEMA WD 1 and UL 498.
1. Products: Subject to compliance with the requirements, provide products by one of the following manufacturers:
   a. Cooper
   b. Hubbell
   c. Leviton
   d. Pass & Seymour

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Arrow Hart).
2. Hubbell Premise Wiring.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

C. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

2.8 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES, 120/277 V, 20 A

A. Snap Switches, 120/277 V, 20 A :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Standards: Comply with UL 20 and FS W-S-896.

B. Pilot-Light, Snap Switches: 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Illuminated when switch is on.
   3. Standards: Comply with UL 20 and FS W-S-896.

C. Lighted Snap Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Premise Wiring.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Handle illuminated when switch is on.
   3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.10 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: Smooth, high-impact thermoplastic, color as selected by Architect 0.035-inch- thick, satin-finished, Type 302 stainless steel.
   3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.11 FLOOR BOXES

A. Description: Floor-mounted box with cover enclosing multiple outlets in a single assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB (Electrification Products Division).

2. Wiremold; Legrand North America, LLC.
3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: 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.

D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Concrete Floor Boxes:
   a. Provide floor boxes classified for use in fire rated concrete floors. Match floor box fire rating to floor assembly. Boxes indicated in floors in contact with the earth must be protected by epoxy paint or must be made of a suitable material to prevent oxidation and deterioration such as cast iron.
   b. Floor boxes must provide a minimum of four inches of adjustment prior to concrete pour and a minimum of 1/2 inch after concrete is set.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Floor Box Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. Covers: Flanged cover for use in tile or carpet, with brushed cable pass-through.
   a. Finish: As selected by Architect.

2.12 POKE-THRU ASSEMBLIES

A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB (Electrification Products Division).
2. Wiremold; Legrand North America, LLC.
3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: 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.

D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.

2. Provide separate paths for management of telecommunications and power cables.
3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Poke-Through Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. Covers: Flanged for use in tile or carpet.
1. Finish: As Selected by Architect.

2.13 SURFACE RACEWAYS

A. Description: Two-piece, aluminum construction multioutlet assembly with brushed natural or satin anodized natural finish with devices, junction fittings, and other matching accessories as required for a complete system and per UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold / Legrand.

C. General:
1. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
2. Provide continuous one-piece cover plates, minimum four feet long.
3. Provide GFCI receptacles for sections of multioutlet assemblies that are indicated within 6'-0" of the edge of a sink.
4. Wiring: Minimum no. 12 AWG solid, Type THHN copper. Provide larger conductor sizes where receptacles with ampacities greater than 20-amperes are indicated.

D. Surface Raceway
1. Multioutlet assembly with prewired, 20-ampere, 125-volt, 2-pole, 3-wire duplex receptacles spaced and circuited as noted on Drawings. on 18-inch centers, alternately connected to two 20-ampere circuits, 120-volt circuits with ground.
2. Receptacle Finish: As noted on Drawings or by Architect.

2.14 SERVICE POLES

A. Dual-Channel Service Poles
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hubbell Premise Wiring.
b. Panduit Corp.
c. Wiremold / Legrand.

2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
3. Poles: Nominal 2.5-inch- square cross-section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
5. Material: As noted on Drawings.

6. Finishes: As noted on Drawings.
7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

PART 3 - Data Communication Outlets: Blank insert with bushed cable opening.
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 Type:
   1. Install GFCI receptacles for all receptacles supplied by single-phase branch circuits rated 150V or less to ground in the following spaces/locations:
      a. Bathrooms.
      b. Kitchens or similar areas with a sink and permanent provisions for either food preparation or cooking.
      c. Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking.
      d. Where the receptacle is installed within 6 feet of the edge of a sink.
      e. Outdoors.
      f. Indoor damp and wet locations.
      g. Locker rooms with associated showering facilities.
      h. Garages, accessory buildings, service bays, and similar areas.
      i. Laundry areas.
   2. Install GFCI receptacles at the following equipment supplied by single-phase branch circuits rated 150V or less to ground and 60 amperes:
      a. Automotive vacuum machines
      b. Drinking water coolers and bottle fill stations
      c. High-pressure spray washing machines
      d. Tire inflation machines
      e. Vending machines
      f. Sump pumps
      g. Dishwashers
      h. Electric Ranges
      i. Wall-mounted ovens
      j. Counter-mounted cooking units
      k. Clothes dryers
      l. Microwave ovens

3. Where GFCI receptacles cannot be installed in a readily accessible location or are not available in the receptacle configuration required to serve a specific load, provide equivalent ground fault circuit interrupter protection by installing a GFCI type circuit breaker as the branch circuit overcurrent protective device for the load.
4. Install tamper-resistant versions of the specified receptacles for all 20A, 125V and 250V nonlocking-type receptacles in the following areas:
   a. All spaces in educational facilities.
   b. Business offices, corridors, waiting rooms, and similar spaces in clinics, medical and dental offices, and outpatient healthcare facilities.
   c. Dormitory units.
   d. Gymnasiums.
   e. Auditoriums.
   f. All spaces in assisted living facilities.

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. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Floor boxes and poke-thru assemblies: For each floor box and poke-thru with communications devices or provisions, provide a conduit stubbed into the accessible ceiling space above the room served by the floor mounted device. Stubbing conduits into the ceiling space below is not permitted.

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each wiring device with panelboard identification and circuit number. In spaces where low voltage lighting control wall stations are utilized, identify panelboard and circuit number of the lights controlled by the low voltage device. In spaces with multiple lighting circuits, provide multiple lables to indicate each lighting branch circuit serving the space. Use hot, stamped, or engraved machine printing with black-filled lettering on front face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 EXTRA MATERIALS (Add. A)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. **Enclosed switches and circuit breakers: 3 for each type and rating installed. (Add. A)**

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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty:
1. Single throw unless otherwise indicated.
2. Three pole, unless otherwise indicated.
3. 240 or 600-V ac.
4. Ampacity as indicated or scheduled.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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. Early Break Auxiliary Contacts: 1 set of normally open contacts that has an early break feature which breaks the contacts prior to the disconnect switch being fully placed in the OFF position.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Arc-Energy Reduction Relay: For switches rated 1200A and over, provide internally mounted device compliant with NFPA 70 article 240.67 requirements, with external display containing pushbutton and visual indicator for maintenance mode.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
2. Littelfuse, Inc.
3. Mersen USA.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Accessories:
1. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Series ratings are not permitted.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Long- and short-time pickup levels.
2. Long- and short-time time adjustments.
3. Ground-fault pickup level, time delay, and I-squared t response.

K. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
5. Arc-Energy Reduction: For circuit breakers rated 1200A or greater, provide circuit breaker compliant with NFPA 70 article 240.87 requirements, with external display containing pushbutton and visual indicator for maintenance mode.

2.6 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 as follows:
1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1);
2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12)
3. Brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel);
4. copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

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 front cover of the enclosure (NEMA 250 Type 1); directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R); externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). 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 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. Kitchen, Wash-Down, and Sterile Processing Areas: NEMA 250, Type 4X , stainless steel .
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4 .
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 with cover attached by Type 316 stainless steel bolts.

3.2 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. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Install control wiring as required including VFC 'make-before-break' contacts as required based on system dynamics (i.e. local disconnect downstream of VFC).

G. Comply with NFPA 70 and NECA 1.

H. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Study."

I. Where motor disconnect switches are installed downstream of a variable frequency drive (VFD), provide 2#12 AWG conductors from the disconnect switch to the VFD.

Terminate wiring in disconnect switch at early break auxiliary contacts and coordinate programming and terminating of conductors at VFD with VFD installer.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections. Testing shall be coordinated with Owner for 3rd party observation.

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) Use a low-resistance ohmmeter.
            a) 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.
         2) 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.
   2. Electrical Tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-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, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
1) Use a low-resistance ohmmeter.
a) 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.
2) 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.
g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. 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.

END OF SECTION

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:
1. Section 260573.13"Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19"Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.
4. Section 263213 "Engine Generators" for source limitations and interfacing systems.

1.2 ACTION SUBMITTALS

A. Coordination of Submittals: Include preliminary power system studies with submittal or submit to Architect prior to submittal. Refer to Section 260573.13 and 260573.16 for additional requirements. Transfer switches submitted prior to preliminary power system studies will be returned without review.

B. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

C. Shop Drawings:
1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Seismic Qualification Data: Certificates, for transfer switches, 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Testing Qualifications:
1. Member company of NETA.
a. Testing Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Match Generator warranty.

1.7 EXTRA MATERIALS (Add. A)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Manufacturer provided “spare parts kit” consisting of components suitable for maintenance or repair by facility technicians employed by owner. Provide 2 spare parts kits for each type of transfer switch. (Add. A)

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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 NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
   2. Short-time withstand capability for 3 cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

L. Battery Charger: For generator starting batteries.
   1. Float type, rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

M. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

N. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via rear and front access.

O. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. ASCO Power Technologies.
4. Russelectric, Inc.

B. Source Limitations: The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Compression type.
6. Ground Lugs and Bus-Configured Terminators: Compression type.
7. Connectors shall be marked for conductor size and type according to UL 1008.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

G. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. Automatic Transfer-Switch Controller Features:
   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
      b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
   10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
   11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
   12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
      a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
      b. Push-button programming control with digital display of settings.
      c. Integral battery operation of time switch when normal control power is unavailable.

J. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
   a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
   b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
   c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
   d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
   e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
   f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
   g. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
   h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
   i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

j. Load shed relay.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:
a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Switch position.
c. Switch in test mode.
d. Failure of communication link.
4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciation and Control System:
1. Remote annunciation and control shall be by the multiple-generator and PV paralleling microgrid monitoring control system. See Section "262313 Paralleling Low-voltage Switchgear" and Section "260913 Electrical Power Monitoring and Control" for annunciation, control and graphics requirements.
2. Include the following functions for indicated transfer switches:
a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Indication of switch position.
c. Indication of switch in test mode.
d. Indication of failure of digital communication link.
e. Key-switch or user-code access to control functions of panel.
f. `Control of switch-test initiation.
g. Control of switch operation in either direction.
h. Control of time-delay bypass for transfer to normal source.
i. General alarm.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.
   1. For each of the tests required by UL 1008, performed on representative devices, for emergency and each systems branch indicated on Drawings. Include results of test for the following conditions:
      a. Overvoltage.
      b. Undervoltage.
      c. Loss of supply voltage.
      d. Reduction of supply voltage.
      e. Alternative supply voltage or frequency is at minimum acceptable values.
      f. Temperature rise.
      g. Dielectric voltage-withstand; before and after short-circuit test.
      h. Overload.
      i. Contact opening.
      j. Endurance.
      k. Short circuit.
      l. Short-time current capability.
      m. Receptacle withstand capability.
      n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3.
   2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
   3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
   4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
   1. Connect signal-before-transfer contacts to elevator controllers where applicable.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to manufacturer's installation instructions.

G. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing equipment, test for compliance with requirements according to NETA ATS.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify that the unit is clean.
      e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      f. Verify that manual transfer warnings are attached and visible.
      g. Verify tightness of all control connections.
      h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
         1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.

j. Verify positive mechanical interlocking between normal and alternate sources.

k. Perform visual and mechanical inspection of surge arresters.

l. 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 contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and PV and run them concurrently.

C. Test sequence of operation step by step for each mode.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LED: Light-emitting diode.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. L70: Point in time where light fixture lumen output is 70% of initial light output.

H. McAdams Ellipses: Color consistency of LED's from chip to chip.

1.2 SUBMITTALS

A. Substitutions are permitted but must be of equal aesthetic and performance subject to Engineer approval via supplier provided submittal and calculation evaluation . Calculations shall be completed to IES industry standards in Lighting Analysts AGI-32 software.

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation as listed on the fixture schedule. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Ballast, including BF.
   3. Energy-efficiency data.
   4. Lamp data: rated life, lumen output, CCT, CRI and wattage.
   5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
   6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

C. Photometric Data Submittals
   1. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for the following lighting fixture types. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

2. Include the following in the photometric report:
   a. List the measured candela values of the photometric distribution in at least three planes, except in the case of an axially symmetrical lighting fixture. Candela curves, lux (footcandle) and lumen tables, and iso-lux (iso-footcandle) contours are not acceptable.
   b. List the type of lamps, ballasts, and lighting control devices, such as lenses and louvers, used with the tested lighting fixture.

D. Shop Drawings: For nonstandard or custom lighting fixtures as indicated on the fixture schule. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

F. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program 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, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

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

D. Comply with NFPA 70.

E. Provide fixtures U.L. listed and labeled for the application.

F. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.4 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or

replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for LED Lighting Fixtures: Manufacturer's standard form in which manufacturer of lightingfixture agrees to repair or replace components, including driver/power supplies and thermal management, that fail in materials or workmanship within five years date of substatial completion.

1.6 EXTRA MATERIALS

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**~~ **LED Boards**: 10 for every 100 of each type and rating installed. Furnish at least one of each type. **(Add. A)**
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Emergency battery pack: One for every 20 emergency lighting unit.
4. LED Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 ALLOWANCES

A. Extra Fixtures

1. Provide an additional 25 exit signs, of each type scheduled above what is indicated on the drawings. Include for each of the extra units, installation of 75 feet of conduit and wire, and connection to the emergency system.
2. Install devices at locations to be determined by the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product by manufacturers indicated on Drawings and specified.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. LED Fixtures: Minimum rated lifetime of L70 at 50,000 hours based on IES LM-79 testing; passive thermal management only unless otherwise indicared.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
      b. Distribution: as indicated
      c. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.

H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED MODULES/BOARDS

A. Minimum rated lifetime of L70 at 50,000 hours based on IES LM-80 testing; 4-step McAdams Ellipse maximum color consistency unless otherwise indicated; 80 CRI minimum unless otherwise indicated.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: As shown in Drawings. Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.Provide as specified on the Drawings.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   6. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "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 fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.2 CLEANING

A. Clean interior surfaces of lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints, smudges, and other marks from lenses, louvers, and reflecting surfaces. Leave free of visible marks.

3.3 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.

2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

1.2 Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
   1. Lamps, including life, output (lumens, CCT, and CRI) and energy-efficiency data.
   2. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficiency Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independant testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   3. Wiring diagrams for power, control, and signal wiring.
   4. Photoelectric relays.
   5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings:
   1. For nonstandard or custom luminaires.
      a. Include plans, elevations, sections, and mounting and attachment details.
      b. Include details of luminaire assemblies. Include dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      c. Include diagrams for power, signal, and control wiring.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.3 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. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One 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.
4. **LED Boards: 10 for every 100 of each type and rating installed. Furnish at least one of each type.**
5. **LED Drivers: One for every 20 of each type and rating installed. Furnish at least one of each type. (Add. A)**

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective cover prior to shipping.

1.6 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of the luminaire installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors

shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Internal driver.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. L70 lamp life of 50,000 hours.

K. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

M. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

N. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

O. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in structural drawings.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

2.4 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.
   1. Shape: As specified on the Drawings. .
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: As specified on the Drawings , continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless -steel bolts.
   2. Cross Section: As specified on the Drawings, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As shown on Drawings and confirmed by architect from manufacturers full range.

2.5 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
   3. Trees: 5 feet from mature drip edge of tree.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03.

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top as detailed in the Plans above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of

bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top as detailed in Plans above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

B. Remote Mounting of Drivers/Power Supplies: Do not exceed the manufacturer's recommended maximum distance between the fixture and the driver/power supply.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
   2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
   3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category data cabling.
2. Data cabling connecting hardware.
3. Optical fiber cabling.
4. Optical fiber connecting hardware.
5. Identification products.
6. Cable management system.

1.2 RELATED DOCUMENTS

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

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. CATV: Community antenna television.

C. CEA: Consumer Electronics Association.

D. EMI: Electromagnetic interference.

E. FTP: Shielded twisted pair.

F. F/FTP: Overall foil screened cable with foil screened twisted pair.

G. F/UTP: Overall foil screened cable with unscreened twisted pair.

H. IDC: Insulation displacement connector.

I. Jack: Also termed outlet, or fixed female connector.

J. LAN: Local area network.

K. MATV: Master antenna television.

L. MMFO: Multimode Fiber Optic.

M. Outlet: Cable connecting device at work area plate.

N. Plug: Also termed connector, or male connector.

O. RCDD: Registered Communications Distribution Designer.

P. RF: Radio frequency.

Q. Screen: Metallic layer, either a foil or braid, placed around a pair or group of conductors.

R. Shield: Metallic layer, either a foil or braid, placed around a pair or group of conductors.

S. S/FTP: Overall braid screened cable with foil screened twisted pair.

T. S/UTP: Overall braid screened cable with unscreened twisted pairs.

U. SMFO: Single Mode Fiber Optic.

V. TDMM: BICSI Telecommunications Distribution Methods Manual.

W. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Telecom structured cabling plan drawings, showing data outlet locations, quantities, and types. Identify and label all data outlet locations on plans.
   2. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   3. Cabling administration drawings and printouts.
   4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.

C. Cable testing plan for each cable type provided.

D. Sustainable Design Submittals, if applicable to Project.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. Certifications for RCDD, installation supervisor, and field inspector.
   2. Certification from cabling manufacturer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation: In general, Closeout Documentation includes the following post construction items:
   1. As-Built Drawings: Provide all items listed under Shop Drawings submittal. Show all information in the As-Built Drawings in its final installed condition, as was constructed.
   2. Operation and Maintenance Manuals (O&Ms).
   3. Cabling Certification and Test Results.

4. Warranty Information.
5. Structured Cabling Solution Manufacturer Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently certified by BICSI as an RCDD to supervise on-site inspection.
   4. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
   5. Manufacturer Certification: Installer must be certified by the horizonal structured cabling solution manufacturer to design and install the system and provide the specified manufacturer warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
   2. Test each coaxial cable for open and short circuits.
   3. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with owner IT.

B. Coordinate telecom equipment room layouts and equipment rack elevations with owner IT prior to work.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling systems shall comply with TIA-568.0-D and TIA-568.1-E

B. Electrical Components, Devices, and Accessories: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70.

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

D. For all installation applications of Project, provide plenum rated cable.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

F. Grounding: Comply with TIA-607-D.

2.2 HORIZONTAL TWISTED PAIR CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols. Cable splices are not allowed in the permanent link.

B. The maximum allowable permanent link twisted pair cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect within equipment room.

C. Based on field conditions, cable pathway routing, and shop drawings, notify Architect if any twisted pair data circuit length will exceed the 295 foot maximum allowable length.

D. Provide an end-to-end Category 6A horizontal structured cabling solution for the Project, as indicated on the Drawings and Specifications.

E. The installed horizonal structured cabling solution shall be certified and warrantied by the cable Manufacturer for a minimum of 25 years. Provide Manufacturer warranty information with Close Out Submittals, as identified under Part 1.

F. Product source limitations:
   1. Obtain all Category data cabling, connectors, and connecting hardware from a single manufacturer.

G. Cable and outlet colors:
   1. Prior to procuring equipment, confirm all cable, outlet, and connector colors with owner IT.

2.3 CATEGORY TWISTED PAIR CABLE

A. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
   1. Leviton

B. Conductors: 100-ohm, 23 AWG solid copper.

C. Standard: Comply with TIA-568.2-D for Category cables.

D. Provide Category 6A cabling.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Jacket Color: Blue.
   1. Part # 11101842 - Blue

2.4 TWISTED PAIR CABLE CONNECTING HARDWARE{CATEGORY TWISTED PAIR CABLE}

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
   1. Leviton General Requirements for Twisted Pair Cable Hardware:
   1. Comply with and match the performance criteria of the provided Category data cabling.
   2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.

D. Source Limitations: Obtain twisted pair cable connecting hardware from same manufacturer as twisted pair cable, from single source.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
   1. Features:
      a. Universal T568A and T568B wiring labels.
      b. Labeling areas adjacent to conductors.
      c. Replaceable connectors.
      d. 48 ports, unless otherwise indicated on Drawings.
      e. Part # E2X1A-S48
   2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
   3. Number of outlet jacks: One for each four-pair Category cable indicated on Drawings.

F. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded ~~**or shielded**~~ twisted pair cable. **(Add. A)**
   2. Standard: Comply with TIA-568.2-D.
      a. Part # ~~**6ASJK-RW6**~~ **SBCPI-S or 6APLG-S6A as required per application.** **(Add. A)**

G. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded ~~**or shielded**~~ twisted pair cable.
   2. Designed to snap-in to a patch panel or cover plate.
   3. Standard: Comply with TIA-568.2-D.
      a. Part # 6AUJK **(Add. A)**

H. Faceplates:
1. Provide faceplates in port configuration as required per data layout on the Drawings.
2. Two-, four-, or six-port, vertical single gang cover plates designed to mount to single gang wall boxes, as required.
3. Eight-, Ten-, or Twelve-port, vertical double gang cover plates designed to mount to double gang wall boxes, as required.
4. Provide plastic or metal cover plates, as coordinated with Architect prior to procuring equipment.
   a. Plastic Cover Plate: High-impact plastic. Coordinate finish and color with Architect.
   b. Metal Cover Plate: Stainless steel, or as coordinated with Architect.
5. For use with snap-in jacks accommodating any combination of twisted pair, coaxial, and optical fiber work area cords.
6. Labels: Machine printed, in the field, using adhesive-tape label. Or snap-in, clear-label covers and machine-printed paper inserts.

I. Patch Cords:
1. Factory-made, four-pair cables, terminated with an eight-position modular plug at each end.
2. Comply with and match the performance criteria of the provided Category data cabling solution.
3. Provide two patch cords for each installed data circuit: One within telecom room at rack, and one for work area outlet.
4. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
5. Provide patch cords in the following lengths:
   a. For work area outlets provide 50% 10' and 50% 15' in length.
   b. For telecom room patch cords provide 25% for each of the following lengths: 3', 5', 7' 10'.
   c. Part # 6AS10-XXL XX = Length
6. Review telecom shop drawings with owner prior to procuring patch cords. Provide patch cords in color as directed by owner.

J. Exterior Wireless AP Enclosures
1. Protective cover for wireless equipment
2. Extends RF coverage outdoors
   a. ACCELTEX 46" x 11" ATS-BOLMNT-11-STDBR
   b. ACCELTEX | ATS-14126-S-L-CG-POE-HC

2.5 **HORIZONTAL OPTICAL FIBER CABLING DESCRIPTION**: Hybrid optical fiber horizontal cabling system shall provide interconnections between equipment room distributor locations and the site CST devices consisting of (4) POE connections. Refer to project plan sheets TY 1.1.1 and TY 1.2.1 for quantities and locations.

A. Fiber optic cabling subsystem consists of horizontal cables, terminations, patch panels, and patch cords or jumpers used for horizontal-to-horizontal cross-connection. Optical fiber interconnecting units may be referred to as light interface units (LIUs).

B. Provide optical fiber horizontal cabling as indicated on the Drawings and Specifications.

C. Product source limitations:

D. Obtain fiber optic cabling, connectors, and connecting hardware from a single manufacturer.

E. Cable and outlet colors:
1. Optical fiber cable and connector colors shall be per industry standards.

1.2 **OPTICAL FIBER CABLE**

A. Manufacturers: Subject to compliance with requirements, Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.:
1. Leviton

B. Standards requirements:
1. Comply with TIA-569.3-E performance specifications.
2. Comply with TIA-598-D fiber optic cable color coding.

C. Provide: MMFO cabling, 2-strand OM3 50/125-micrometer, tight buffer, 850-nm laser-optimized, Aqua. Length at regular intervals not to exceed 40 inches. Splicing: Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.

1.2 **OPTICAL FIBER CABLE HARDWARE**

A. Manufacturers: Subject to compliance with requirements, Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.: Leviton

B. Standards requirements:
1. Comply with and match the performance criteria of the provided optical fiber horizontal cabling.
2. Comply with TIA-569.3-E performance specifications.
3. Comply with TIA-598-D fiber optic cable and connector color coding.
4. Leviton
   a. Hybrid Cable, Loose Tube 4 Strand Single Mode Part # ACRC004AB0403-002X12AWG
   b. Hybrid Cable Tight Buffer 2 Strand Single Mode Part # HDRC002AB0707-002X12AWG

C. Source Limitations: Obtain optical fiber connecting hardware from same manufacturer as optical fiber cable, from single source.

D. Fiber Patch Panels or LIUs: Modular panels housing multiple-numbered, duplex cable connectors.
1. Rack mount in telecom equipment racks.

2. Provide fiber patch panel in each telecom room, sized to accommodate one duplex connector for each pair of installed fiber strands assigned to field, plus 25 percent spare.
3. Provide all required fiber cassettes, adapter panels, and associated components.
4. Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.
5. Leviton
    a. OneReach Part # 81001531
    b. 250-Watt Power Supply Part # 81001536
    c. Media Module Part # 81001262
    d. M8 Pigtail Part # 2 x 18 AWG Part # 11099456
    e. 1 Port Remote Part # 81001513
    f. 2 Port Remote Part # 81001535

E. Fiber Cable Connecting Hardware:
1. Quick-connect, duplex, Type LC connectors, with UPC polish type. Insertion loss not more than 0.75 dB. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-569.3-E.

F. Faceplates:
1. Provide faceplates in port configuration as required per telecom cabling layout on the Drawings.
2. Vertical single gang cover plates designed to mount to single gang wall boxes, with fiber optic connectors as required.
3. Provide plastic or metal cover plates, as coordinated with Architect prior to procuring equipment.
4. Plastic Cover Plate: High-impact plastic. Coordinate finish and color with Architect.
5. Metal Cover Plate: Stainless steel, or as coordinated with Architect.
6. For use with snap-in connectors accommodating any combination of twisted pair, coaxial, and optical fiber work area cords.
7. Labels: Machine printed, in the field, using adhesive-tape label. Or snap-in, clear-label covers and machine-printed paper inserts.

G. Fiber Patch Cords:
1. Factory-made, dual fiber cables with duplex connector at each end, matching the supplied fiber connector Type.
2. Comply with and match the performance criteria of the provided optical fiber horizontal cabling.
3. Provide two patch cords for each installed fiber optic strand pair: One patch cord for each end.
4. Provide patch cords in the following lengths:

H. Provide 25% for each of the following lengths: 3', 5', 7', 10'.
1. Review telecom shop drawings with owner prior to procuring patch cords.

1.2 CABLING IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Worldwide
2. HellermannTyton
3. Kroy
4. Panduit

B. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 270553 "Identification for Communications Systems."

1.3 SOURCE QUALITY CONTROL

A. Factory test twisted pair cables according to TIA-568.2-D.

B. Factory test optical fiber cables according to TIA-569.3-E.

C. Factory test coaxial cables according to TIA-568.4-E.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1.4 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database and graphic capabilities.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
1. iTRACS Corporation{ITRACS CORPORATION}
2. Telsoft Solutions{TELSOFT SOLUTIONS}

C. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.
1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:
1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

F. Closeout Submittal Requirements:
1. Software and Firmware operational documentation.
2. Software operating and upgrade manuals.
3. Program Software Backup: On compact disk or USB, complete with project data files.
4. Software application device address list data files.
5. Printout of device address list and graphic screens.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for communications device cabling conduit systems to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 PREPARATION

A. Comply with TIA/EIA 606-D, "Administration Standard for Commercial Telecommunications Infrastructure."

B. In meetings with Architect and Owner, present, review and coordinate Project planning documents.

C. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

2.3 INSTALLATION

A. Comply with all state and local ordinances, codes, and regulations.

B. Coordinate all communications conduit rough-in requirements with EC and GC prior to work.

2.4 WIRING METHODS

A. Routing:
1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
5. Where installed within conduit, conduit size shall be minimum 1 inch, maximum conduit fill 40%.
6. Refer to the Drawings for typical device conduit requirements.
7. Data transmission wiring shall not share conduit with other building wiring systems.
8. Install plenum cable in environmental air spaces, including plenum ceilings.
9. For all installation applications, provide cabling rated for the environment in which it is installed.
    a. Provide riser rated cabling as required.
    b. Provide plenum rated cabling as required.
    c. Provide indoor/outdoor rated cabling as required.
    d. Provide outside plant (OSP) or direct burial cabling as required.

e. Non-rated OSP cabling must be terminated within 50 feet from its point of entry into the building, unless installed within continuous metallic conduit pathway.

B. Wiring within Enclosures:
1. Bundle, lace, and train cables within enclosures.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
3. Provide and use lacing bars and distribution spools.
4. Install conductors parallel with or at right angles to sides and back of enclosure.

2.5 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems"
2. 270528 "Pathways for Communications Systems"
3. 270536 "Cable Trays for Communications Systems"
4. 270544 "Sleeves and Seals for Communications Pathways and Cabling"

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

2.6 INSTALLATION OF CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIMM Ch 5 "Cable Installation" and Ch 6 "Cable Termination Practices."
3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
4. Cables may not be spliced.
5. Secure and support cables not more than 6 inchesfrom cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

11. In communications equipment rooms, install and manage a 10 foot service loop for all cables.

C. Open Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. J-hook installation: Suspend twisted pair cable not in a wireway or pathway a minimum of 8 inchesabove ceilings by cable supports not more than 60 inches apart, and at each change in direction. Hook spacing shall allow no more than 6 inches of slack. Size J-hooks to allow a minimum of 25 percent future capacity without exceeding design capacity limits. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feetlong not less than 12 inchesin diameter below each feed point.

E. Twisted Pair Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568.2-D.
2. Do not untwist twisted pair cables more than 1/2 inchfrom the point of termination to maintain cable geometry.

F. Optical Fiber Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, TIA-569.3-E and TIA-526-14-D.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

G. Coaxial Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568.4-E.
2. All installed coaxial circuits and associated equipment must comply with FCC requirements for minimum signal strength at work area outlets.
3. Outdoor Coaxial Cable Installation:
   a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-E for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

2.7 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

2.8 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inchclearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

2.9 IDENTIFICATION

A. In addition to requirements in this article, comply with identification requirements of TIA/EIA 606-C.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications equipment rooms, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
1. Label each cable within 4 inches f each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
   a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
   b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

2.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Visually inspect cable jacket materials for NRTL certification markings.
2. Inspect twisted pair cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test data circuit permanent link after termination.
5. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test coaxial cable distribution subsystem for compliance with TIA-568.4-E. Test cables after termination.
6. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
7. Twisted pair performance tests include but may not be limited to:
   a. Test for each data circuit permanent link. Perform the following tests according to TIA/EIA-568-C.1 and TIA/EIA-568.2-D:
      1) Wire map.
      2) Length (physical vs. electrical, and length requirements).

3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

8. Coaxial Cable Tests:
   a. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.
   b. Apply RF signal to each installed circuit and test for signal strength performance at work area outlet. All installed coaxial circuits and associated equipment must comply with FCC requirements for minimum signal strength at work area outlets.
9. Optical Fiber Cable Tests:
   a. Link end-to-end performant test include but may not be limited to:
      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-D, Method B, One Reference Jumper.
      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.
      3) Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI TDMM, or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Where not-compliant with specified criteria, correct terminations and/or remove and replace cabling if required, to remedy deficient installation.

E. Collect results, assemble, and submit test and inspection reports.

2.11 DEMONSTRATION AND TRAINING

A. Provide four hours of training. Train owner's IT maintenance personnel in horizontal cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments when making revisions to the installed horizontal cabling system.

END OF SECTION

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This work includes designing and providing a new, completely supervised, multiplexed, addressable, intelligent, voice evacuation fire alarm system (devices, components and wiring) as described herein and on the contract drawings for the Project. All fire alarm panels and equipment are to be compatible with existing campus Notifier Onyx panels located in existing campus buildings.
   1. Include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, software and programming, acceptance testing and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide equipment with components identical to and bearing the labeling of those approved for intended use by independent testing laboratory.

B. Section Includes:
   1. Fire-alarm control unit.
   2. Manual fire-alarm boxes.
   3. System smoke detectors.
   4. Heat detectors.
   5. Notification appliances.
   6. Device guards.
   7. Firefighters' two-way telephone communication service.
   8. Magnetic door holders.
   9. Remote annunciator.
   10. Addressable interface device.
   11. Digital alarm communicator transmitter.
   12. Radio alarm transmitter.
   13. Notification appliance circuit power extender panel (NAC).
   14. Network communications.

C. Related Requirements:
   1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
   2. Division 07 SectionPenetration Firestopping for fire stopping requirements not in this Section.
   3. Provisions of Division 26 SectionsCommon Work Results for Electrical and Raceways and Boxes for Electrical Systems apply to this Section.
   4. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. 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.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. 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.
   9. Include performance parameters and installation details for each detector.
   10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
   12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning 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.
   13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

14. 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: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
1. Provide 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.
a. 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.
b. 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.
c. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 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.

D. Sample Warranty: For special warranty.

1.5 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 017823 "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.

1.6 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. 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. Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
5. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
6. Keys and Tools: One extra set for access to locked or tamper proofed components.
7. Audible and Visual Notification Appliances: One of each type installed.

8. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
9. **Manual Pull Stations: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type. (Add. A)**
10. **Control Modules: Quantity equal to 5 percent of amount of each type installed, but no fewer than one unit of each type. (Add. A)**

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as minimum fire-alarm Level III technician.

B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.8 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. 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.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 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.

1.10 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 final acceptance.

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 Notfier system. 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 voice/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 NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. All campus buildings are to be networked and report to Control Room SEC-2146 within the hospital.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.
7. Fire standpipe system.
8. Dry system pressure flow switch.
9. Fire pump running.
10. Preaction systems.

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 fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Preaction system.
10. Recall elevators to primary or alternate recall floors.

11. Activate elevator power shunt trip.
12. Activate emergency lighting control.
13. Activate emergency shutoffs for gas and fuel supplies.
14. Record events in the system memory.

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.

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.
6. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design notification appliances, and smoke and heat detectors.
1. Material properties indicated in this Section shall be considered as minimum properties.

B. 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 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Notifier.

B. General Requirements for Fire-Alarm Control Unit:
   1. Compatible with existing campus Notifier panels.
   2. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
      a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
      c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
      d. The FACP shall be listed for connection to a central-station signaling system service.
      e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
   3. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
   4. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
   1. Pathway Class Designations: NFPA 72, Class B .
   2. Pathway Survivability: Level 3(until circuit reaches zone of notification/signaling, then Level 0).
   3. Install no more than 100 addressable devices on each signaling-line circuit.
   4. Serial Interfaces:
      a. One dedicated RS 485 port for central-station operation using point ID DACT.
      b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
      c. One USB port for PC configuration.
      d. One RS 232 port for voice evacuation interface.

F. Notification-Appliance Circuit:
   1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
   2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
   3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:
   1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
      a. Elevator lobby detectors except the lobby detector on the designated floor.
      b. Smoke detector in elevator machine room.
      c. Smoke detectors in elevator hoistway.
   2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
   3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
   a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   1. Batteries: Sealed lead calcium.
   2. Secondary power duration: 24 hours minimum.

O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 PREACTION SYSTEM

A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Notifier.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   3. Station Reset: Key- or wrench-operated switch.
   4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
   5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Notifier.

B. 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. Self-Testing: Detectors are to be capable of self testing in accordance with NFPA, in locations where applicable.
   7. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
   8. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable 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 per minute.
      b. Fixed-temperature sensing characteristic of combination smoke- and 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.
      c. Multiple levels of detection sensitivity for each sensor.

d. Sensitivity levels based on time of day.

C. 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.).

D. 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.).

E. 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.

2.8 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Notifier.

B. General Requirements for Heat Detectors: Comply with UL 521.
1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wheelock.
   2. Federal Signal Corporation.
   3. GE UTC Fire & Security; A United Technologies Company.
   4. Gentex Corporation.
   5. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance 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. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- 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, white.

D. 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: surface mounted and bidirectional.
   6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.10 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 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.

2.11 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Surface cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 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, fire pumps, and emergency generators for monitoring status

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to circuit-breaker shunt trip for power shutdown.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   4. Manual test report function and manual transmission clear indication.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.
   8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 NETWORK COMMUNICATIONS

A. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

B. Provide Honeywell Connected Life Safety Services (CLSS) to interconnect all campus buildings on the IHS LAN network.

C. Provide integration gateway using BACnet for connection to building automation system.

D. Notifier client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard, and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

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 ELECTRIC POWER

A. Provide primary power for all fire alarm panel equipment from the emergency AC service to the building where shown on the drawings. Power shall be 120 VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices. Make the service connection for the fire alarm panel equipment at the junction box labeled "FACP Connection" connected to the emergency distribution panel where shown. The circuit breaker shall be painted red, marked "Fire Alarm Control Circuit" and shall be provided with a lockable handle or cover. All 120 VAC primary power circuits shall be equipped with surge protection devices (SPD).

3.3 SYSTEM FIELD WIRING

A. Wiring within Cabinets, Enclosures, Boxes, Junction Boxes and Fittings:
   1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure or cabinet.
   2. Connect conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting or junction box, to terminal blocks.
   3. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved pressure type terminal blocks, which are securely mounted.
   4. Wire nuts and similar devices are not acceptable.

B. Provide a terminal cabinet where indicated on the Drawings.
   1. Use terminal sizes appropriate for the size of the wiring to be connected.
   2. Provide labeling of conductor terminations, and a diagram permanently mounted in the terminal cabinet, showing all conductors, their labels, their circuits and their interconnection.
   3. Provide terminal cabinets having 25 percent spare backbox space.

C. Fire Alarm Wiring:
   1. Provide fire alarm circuits in accordance with the equipment manufacturer’s requirements, NFPA 70 – National Electrical Code, specifically Article 760 and these Specifications. Provide wire size sufficient to prevent voltage drop problems.
   2. Circuits operating at 24 VDC shall not operate at less than 21.6 volts.

3. Audio speaker circuits operating at 70.7 VRMS shall be designated to operate at less than 0.5 dB (12.5 percent) loss. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.
4. Install all conductors in minimum electrical-metallic tubing (EMT), with a minimum diameter of 3/4 inch.
5. Use shielded wiring where recommended by the manufacturer. For shielded wiring, the shield shall be grounded at only one point, which shall be in or adjacent to the FACP. Treat the drain or shield wires as a fire alarm conductor, landed on terminal strips. The drain wire shall be sleeved or insulated to within 1 inch of its termination. T-taps are not permitted. Circuits to fan shutdown systems shall terminate in terminal cabinets within 3 feet of the controllers for those systems

D. Wiring Installation:
1. All alarm initiating devices and supervisory initiating devices shall be connected on Style 4 two (2) wire (Class B) Signaling Line Circuits (SLC). Unsupervised wiring (point wires) shall not be permitted. Parallel branch circuit wiring shall be permitted on the addressable SLCs.
2. All alarm indicating devices shall be connected on Style Y two (2) wire electrically supervised circuits and on a minimum of two active circuits.
3. Wiring to initiating and supervisory devices and to fire alarm annunciators shall be with two (2) conductor twisted size 16 solid copper UL listed fire alarm system wire, subject to manufacturer's recommendations.
4. Wiring to alarm indicating devices shall be with two (2) conductors twisted No. 14 AWG solid copper UL listed jacketed fire alarm system wire, subject to manufacturer's recommendations.
5. Power wiring, operating at 120 VAC minimum, shall be No. 12 AWG solid copper, 600 VAC rated THHN/THWN insulation.
6. All other wiring shall be solid copper No. 14 AWG minimum with 600 volt THHN insulation except as specifically noted.
7. No splicing of wires is permitted except on terminal blocks in annunciators, control panels or properly labeled terminal cabinets as shown on the drawings.
8. The use of wire nuts or similar type devices is not permitted.

E. Conductor Terminations:
1. All devices shall have terminals for each wiring connection.
2. No splicing of any type shall be permitted in pull boxes, to include crimp terminals.
3. No specific color coding is required for any circuit; however, labeling of any circuit at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection.
4. Each conductor or cable shall have a permanent label to provide a unique and specific designation.
5. Each terminal cabinet, FACP and remote fire alarm control unit shall contain a laminated drawing which indicates each conductor, its label, circuit and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel or unit so that it does not interfere with the wiring or terminals.

6. All wires shall be labeled at both ends.. Use plastic wire ties and wire tie mounts to ensure a neat quality appearance.

F. Conduit Installation:
1. Conceal all electrical conduits above suspended ceilings and behind walls, except in unfinished areas where conduit may be surface mounted, unless otherwise specified.
2. The use of metal clad (MC) cable is acceptable only in concealed spaces and only as allowed by other Codes, including channeled walls and above suspended ceilings. The MC Cable shall be installed and supported in accordance with NFPA 70-NEC.
3. MC cable is not acceptable for smoke control system wiring.
4. All exposed conduit shall be painted to match adjacent finish.

G. Conduit Size:
1. Both exposed and concealed conduit including risers up to 2 inches in diameter shall utilize compression type steel fittings and connectors.
2. Unless otherwise noted, all conduit provided shall be 3/4 inch minimum trade size.
3. Vertical risers shall be one inch diameter minimum.
4. Limited use of 1/2 inch conduit is permitted on horizontal runs when a reduced diameter is required for better concealment. Where necessary, 1/2 inch diameter flex conduit may be fished or used for concealed work. Provide plenum rated wiring conductors (Type FPLP) when flex conduit is used.

3.4 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 NFPA 70 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 monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Equipment Mounting: Install fire-alarm control unit on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
1. Install seismic bracing. Comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

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 concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use 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.

D. Equipment Mounting: Install fire-alarm control unit on finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

F. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

G. 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 .
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

H. 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.

I. 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 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.

J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

K. 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.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Visible Alarm-Indicating Devices: Install weather-proof device at exterior fire department connection. Locate in accordance with local authority having jurisdiction.

N. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.5 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.6 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 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm 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 from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated HVAC duct systems.
   2. Magnetically held-open doors.
   3. Electronically locked doors and access gates.
   4. Alarm-initiating connection to elevator recall system and components.
   5. Alarm-initiating connection to activate emergency lighting control.
   6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
   7. Supervisory connections at valve supervisory switches.
   8. Supervisory connections at low-air-pressure switch of each dry-pipe/pre-action sprinkler system.
   9. Supervisory connections at elevator shunt-trip breaker.
   10. Data communication circuits for connection to building management system.
   11. Data communication circuits for connection to mass notification system.
   12. Supervisory connections at fire-extinguisher locations.

13. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
14. Supervisory connections at fire-pump engine control panel.

C. Notifier client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard, and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

3.7 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.

3.8 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.

3.9 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 with the assistance of a factory-authorized service representative:
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 final acceptance, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.10 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.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At final acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of final acceptance. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 328000 - IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes specifications and general provision for automatic irrigation system using reclaimed water supply.

1.2 QUALITY ASSURANCE AND WARRANTY

A. The Contractor warrants to the Owner that the materials used and furnished for the project will be new and that the work will be good quality and free from defects for a period of one year from the date of final acceptance by the Owner.

B. For a period of one year from the date of final acceptance of the work performed under this contract, the Contractor shall promptly furnish, without cost to the Owner, any and all parts and labor that should prove to be defective in material or workmanship.

1.3 JOB CONDITIONS

A. Examine work in place on which this work is dependent. Defects which may influence the satisfactory completion and performance of this work shall be corrected in accordance with requirements of the applicable section of work prior to commencement of the work. Commencement of the work covered under this section shall be construed as the work in place being acceptable for satisfying the conditions of this section.

B. Protection: Protect the work and adjacent work against damage during the progress of the work.

1.4 SCOPE OF WORK

A. The work shall include all pipe, fittings, isolation valves, sprinkler heads, field wiring, pump station, concrete pump station support pads, irrigation controller, controller power wire, connection for power and other related items, as required to meet the provisions of this specification, and the plans for this project.

B. Irrigation system component submittals shall be approved by the Irrigation Consultant before the Contractor begins installation of the irrigation system.

C. Field staking of the irrigation system shall be the responsibility of Contractor. The irrigation consultant shall approve the field staking before the Contractor begins installation of the irrigation system.

D. Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper installation and completion of the work whether each necessary item is mentioned herein or not.

E. The irrigation system shall be installed per the plans and specifications and not the way the contractor always does it.

1.5 IRRIGATION CONTRACTOR QUALIFICATIONS

A. The Irrigation Contractor shall have installed at least five (5) irrigation projects of similar size and scope within the last three years. The Contractor must submit, when requested, a listing of projects which meet this requirement along with the proper contact name, address and telephone number of the parties that can verify the information.

B. The Irrigation Contractor shall be certified by the Irrigation Association as a Certified Irrigation Contractor (CIC). The contractor shall provide with submittals, a copy of their CIC certificate.

C. The Contractor shall designate a competent project superintendent and any necessary assistants to oversee the project for the entire phase of the installation. The superintendent shall have the authority to represent the Contractor in their absence and all directives given to the superintendent shall be as binding as if given to Contractor.

1.6 CODES AND INSPECTIONS

A. The entire installation shall fully comply with all local and state laws and ordinances and with all the established codes applicable thereto. The Contractor shall be responsible for and take out all required permits, arrange for all necessary inspections and shall pay any fees and expenses in conjunction with the same as a part of the work under this contract.

1.7 TESTING THE SYSTEM

A. The Contractor shall conduct a pressure test on the irrigation system upon completion of construction.

B. This test shall consist of pressurizing the system to 100 and closing the pump station isolation valve. The pressure in the system shall not drop more than 10 psi in three hours.

1.8 DRAWINGS OF RECORD

A. After completion of the system installation, the Contractor shall furnish to the "Owner" "Drawings of Record" on D size paper showing all sprinkler heads, valves, wire splice boxes, pipelines, field controllers, and wire routes.

B. Dimensions from two fixed points for all main line isolation valves, zone valves, water reel connections and wire splice boxes will be required on the "Drawings of Record".

1.9 INSTRUCTIONS

A. After completion and testing of the system, the Contractor will instruct the Owner's personnel in the proper operation and maintenance of the system to the satisfaction of the Owner's grounds maintenance supervisor.

B. Two sets of instruction sheets and parts lists covering all equipment incorporated into two Owner's manuals bound in three ring binders.

PART 2 - PRODUCTS

2.1 SPRINKLER EQUIPMENT

A. All products shall bear reclaimed water supply identifiers.

B. Sprinklers shall perform with regards to the diameter of throw and volume at a given pressure as specified on the plans.

C. Electric zone valves shall be hydraulically operated diaphragm type and actuated via 24 VAC solenoid and digital single station decoder.

D. Quick coupler valves shall be bronze body with 1-inch IPS female thread inlet and a 1-inch key outlet and as manufactured by Hunter Industries or an approved equal. The contractor shall provide the Owner with four quick coupler keys equipped with 1 " fpt x 1" mht hose.

E. Sprinkler heads shall perform as specified on the plans.

F. Electric zone valves shall be as specified on the plans.

2.2 CONTROL SYSTEM

A. A single solid state controller utilizing zone valve decoders shall be installed to operate the irrigation system.

B. The controller shall have a maximum capacity of 72 stations with up to six separate communication paths.

C. The controller shall have the capacity to provide 6 independent programs with up to 6 starts per day per schedule.

D. The controller shall be programmable on either a time based 7 day cycle of selected intervals or sensor controlled to begin and terminate irrigation based on soil moisture levels.

E. The controller shall have a water budget feature adjustable from 20 to 300 percent.

F. The controller shall be contained in a wall mountable metal cabinet.

G. The automatic controller shall be as indicated on the plans and as manufactured by Hunter Industries or an approved equal.

H. The zone valve decoders shall single station units and compatible with the zone control valves and irrigation control system.

I. The controller shall include a wireless rain sensor compatible with the irrigation controller.

J. The control system shall include a hand held remote control package compatible with the irrigation control system.

2.3 WIRE AND FITTINGS

A. The decoder communication cable shall consist of two 14 gauge copper conductors. Each conductor shall be insulated with PVC and the pair contained in a high density polyethylene jacket suitable for direct burial.

B. All wire splices are to be made with full size wire nuts and moisture proof splice kits for use with three (3) wires maximum.

C. The decoder communication cable shall be equipped with ground electrodes per the plan and plan details. The ground electrodes shall be rod 5/8" by 8 foot copper clad ground rods. Connection of the decoder ground wire ground rod shall be completed with a copper acorn clamp.

D. All decoder cable shall be furnished in minimum 2,500' reels.

E. All decoder cable shall be as specified on the plans and as manufactured by Paige Electric, Regency Wire and Cable or approved equal.

F. The moisture proof wire splice kits shall be shall be 3M DBY-6 or approved equal.

2.4 PIPE AND FITTINGS

A. All products shall bear reclaimed water supply identifiers.

B. All pipe shall be manufactured from virgin polyvinyl chloride resin, and meet ASTM D1784, ASTM D2241, and Product Standard 22 for PVC pipe.

C. All PVC pipe shall be furnished in 20'-0" lengths. All 4 and 3-inch main line pipe shall with shall have one end belled for push joint connection and meet ASTM D3239 for joint and gasket specification. All 3-inch and smaller lateral line pipe shall have one end belled for solvent weld connection.

D. All PVC pipe shall be pressure rated @ 200# (PSI) for continuous service @ 73F. and meet SDR-21 dimension ratio for wall thickness.

E. All main line pipe fittings 3-inch and larger shall be ductile iron, bituminous coated type for gasket joint connection to the pipe. All lateral pipe fittings 3-inch and smaller shall be Schedule 40 pressure rated @ 200# (PSI), and constructed for solvent weld attachment to PVC pipe.

F. PVC gasket joint service tees may be used for connection of the zone control valves and quick coupler valves to the main line pipe.

G. All Schedule 40 fittings shall be full sized. Any required reduction of pipe size shall be accomplished with slip by slip or slip by female pipe thread reducer bushings. Molded reducing type fittings will not be accepted.

H. All sprinkler heads shall be installed with pre-assembled 0-ring type swing joints, with full 360 degree adjustment in three planes. Swing joints shall be as manufactured by Lasco, Spears or an approved equal.

I. All PVC pipe shall be as manufactured by Cresline, Eagle, Northern, Freedom or an approved equal.

J. The ductile iron fittings shall be as manufactured by Harrington Corporation or an approved equal. The PVC schedule 40 solvent weld fittings shall be as manufactured by Cresline, Spears, Lasco, or an approved equal.

2.5 VALVES AND ACCESS BOXES

A. All products shall bear reclaimed water supply identifiers.

B. All Isolation Valves shall be AWWA approved iron body resilient seal wedge disc, non-rising stem with a square operating nut and gasket joint hubs sized for IPS PVC pipe.

C. All isolation valves shall be as manufactured by American Flow Control, Waterous or an approved equal. The Contractor shall provide the Owner with two isolation valve operating keys.

D. Control valve boxes shall be a minimum of 10 inch diameter valve pits.

E. Quick coupler valve boxes shall be in 6-inch economy boxes.

F. Isolation, zone and quick coupler valve boxes shall be equipped with green lids. Wire splices and surge protection boxes shall be equipped with black lids.

G. Control and quick coupler valve boxes shall be per the plan details and as manufactured by Us Filter / Plymouth Products, Carson/Brooks or an approved equal.

2.6 EXTRA MATERIALS (Add. A)

A. Spare valves: (Add. A)

1. Provide (3) 100-PESB/IVM – PRS-D Replacement Kits. (Add. A)

2. Provide (3) 150-PESB/IVM – PRS-D Replacement Kits. (Add. A)

B. Spare Valve Rebuild Kits: Provide (3) IVM-SOL replacement parts. (Add. A)

PART 3 - EXECUTION

3.1 SPRINKLER EQUIPMENT

A. All sprinkler heads shall be installed per the manufacturer's instructions and the plan details.

B. Each quick coupler valve shall be installed per the manufacturer's instructions and the plan details.

3.2 CONTROLS

A. The controller shall be installed per the manufacturer's instruction and the plan details.

B. The automatic rain switches shall be located on the control enclosure and installed per the manufacturer's instructions.

C. Grounding and surge protection for the controllers shall be per the manufacturer's recommendations and the plan details.

3.3 WIRE AND FITTINGS

A. Control wire between field satellites and 24 VAC valve solenoids, may be laid in the opencut trench beside irrigation piping per the installation detail, down fed in the pipe pulling operation, or in a separate pulling operation. Control wire, when laid with pipe pulling operation must be "down fed" to minimize any tendency to stretch wire or PVC insulation.

B. Slack must be provided for expansion or contraction and tensile stress must be avoided during installation.

C. In the event a cable must be routed under a roadway, it shall be installed in a sleeve with the pipe.

3.4 PIPE AND FITTINGS

A. Installation for all PVC main line piping shall be open cut trench. A trace wire shall be installed with all trenched pipe.

B. Installation for all PVC lateral piping shall be either open cut trench or vibratory plow.

C. All PVC main line piping shall be a installed a minimum of 24 inches below surface grade.

D. All PVC piping lateral piping shall be a installed a minimum of 16 inches below surface grade.

E. All piping installed in an open cut trench is to be covered with the trench spoils.

F. Unsuitable excavated material shall be removed from the work area and disposed of on site by the Contractor.

G. All solvent weld joints are to be completed using a high etch PVC primer and a heavy body PVC cement.

H. All piping, valves and fittings are to be adequately supported, anchored, braced or strapped to withstand hydraulic thrust even though such supports are not shown on the drawings. Special attention shall be performed to ensure that the thrust block mass is adequate to restrain pipe, fitting, or valve movement.

I. All horizontal bends on main lines shall be buttressed with either poured concrete or concrete block at all changes of direction. Concrete buttress dimensions shall be determined in the field by the Irrigation Contractor.

J. Additional supports, as recommended by the pipe manufacturer, shall be installed to manufacturer's requirements.

K. Pipe interiors must be cleaned before installation and kept clean by the use of test plugs or duct tape.

L. It shall be the responsibility of the Contractor to provide adequate protection to compensate for expansion or contraction of the plowed pipe during installation. Plowed pipe should be provided with adequate time to adjust to ground temperature before any connections are made.

M. In the event a pipe must be routed under a walk or roadway, it shall be installed in a schedule 40 PVC sleeve.

N. The sleeves shall be one pipe size larger than the pipe it is to contain. If the sleeve is also contain wire, then it shall be two pipe sizes larger than the pipe it is to contain.

3.5 VALVES AND ACCESS BOXES

A. All valves and valve boxes shall be installed per the plan details.

B. Valve boxes shall be notched to fit over the pipe.

3.6 PUMP STATION(S)

A. The pump station and wet well shall be installed per the manufacturer's instructions and the plan details.

3.7 BACKFILL

A. Backfill shall be suitable excavated material free from rock and debris.

B. All trenches shall be settled by mechanically compacting in six inch layers immediately after the backfill has been placed. Care shall be taken not to disturb the pipe or its foundation.

C. All open trenches shall be filled the same day as they are opened except where required for continuation of work the following day. Pipe in open trenches shall be protected from damage or vandalism.

3.8 CLEANING THE PREMISES

A. The Contractor shall at all time keep the premises on which the work is being done, and the adjoining premises, clean of rubbish caused by their work.

B. Upon completion of the job, Contractor shall clean up all soil and debris caused by their work and leave the job in a neat and clean condition. All debris removed from the job shall be taken away from the premises at the Contractor's expense.

3.9 SYSTEM WINTERIZATION

A. This irrigation system is designed to be winterized by purging the water from the piping system and control valves through the sprinkler heads via the induction of high volume compressed air with a minimum 300 to 400 CFM air compressor.

B. After closing the water supply valve, a trailer mounted, gas driven compressor can be attached to the irrigation system main line.

C. As part of this contract, the Contractor shall winterize this system in the fall succeeding installation and put the system back into operation in the spring. The cost of renting the air compressor for winterizing the irrigation system shall be the responsibility of the Contractor.

D. This winterization and spring start up requirement shall be utilized to train the Owner's grounds maintenance personnel in the proper procedure of same.

END OF SECTION